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**Water Budget Analysis for the
Everglades Nutrient Removal Project
and Stormwater Treatment Area 1 West
(August 20, 1998 to June 30, 2000)**

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by

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EXECUTIVE SUMMARY

The Everglades Nutrient Removal Project (ENR) is a 1,544 hectare (ha) or 3,815 acre (ac) constructed wetland, designed and operated for the demonstration of phosphorus (P) reduction from agricultural runoff/drainage. The ENR is located in south Florida (26° 38' N, 80° 25' W) at the eastern edge of the Everglades Agricultural Area (EAA). The EAA is a 240,000 ha (593,000 ac) highly productive irrigation/drainage basin with a major production of sugarcane. Ecological changes in the Everglades have been partially attributed to an increase in phosphorus (P) concentration in the inflow waters. Local, state and federal initiatives have been taken to reduce P associated with agricultural runoff/drainage. The ENR is an example of one of these initiatives and is a field scale prototype for a larger scale Stormwater Treatment Area (STA). It was operated for close to five years and became part of the larger constructed wetland, Stormwater Treatment Area 1 West (STA-1W). The total area of STA-1W is 2,772 ha (6,849 ac) with Cell 5, the northern expansion of ENR, covering 1,228 ha (3,034 ac).

This report has two sections. Section I presents water budget analysis for the ENR covering the last months of the project before it started fully operating as part of STA-1W (August 20, 1998 to June 30, 1999). Section II of this report presents the first year water budget for STA-1W (July 1, 1999 to June 30, 2000).

The total inflow to the ENR through the inflow pump for the 315-day study period was 7,620 hectare-meters (ha-m) or 61,774 acre-feet (ac-ft) and the total outflow through the outflow pump was 7,768 ha-m (62,974 ac-ft). Estimated seepage inflow from the L-7 levee through the roadside culverts was a total of 426 ha-m (3,453 ac-ft). The seepage recirculation pump had a total flow of 2,519 ha-m (20,421 ac-ft). Total areal average rainfall for the study period was 115.2 centimeters (cm) or 45.4 inches (in) and the total areal average evapotranspiration was 108.6 cm (42.8 in). The mean hydraulic loading rate for the study period, based on the G-250 pump inflow, was 1.57 centimeters per day (cm d^{-1}) or 0.62 inches per day (in d^{-1}). The mean-estimated volume was computed from the area-weighted (by cell) mean depth of 48.7cm (19.2 in) and total area of 1,544 ha (3,815 ac). The estimated mean hydraulic retention time was 30.5 days.

STA-1W has been in operation for one year but the main outflow structure pump station G-310 has been under construction. For the period of analysis, the total inflow through the spillway was 14,636 ha-m or 118,651 ac-ft and the total outflow through the pump was 14,977 ha-m (121,416 ac-ft). Estimated seepage inflow from the L-7 levee through the roadside culverts was a total of 438 ha-m (3,551 ac-ft). The seepage and recirculation pump had a total flow of 6,688 ha-m (54,218 ac-ft). Total areal average rainfall for the study period was 100.8 cm (39.7 inches) and the total areal average evapotranspiration was 137.6 cm (54.2 inches). The sum of the errors and unknowns, was 1.1 percent of the inflows to the system. The mean hydraulic loading rate for the one-year period, based on the G-302 inflow, was 1.45 cm d^{-1} (0.57 in d^{-1}). The mean-estimated volume was computed from the area-weighted (by cell) mean depth of 51.9 cm (20.4 inches) and total area of 2,772 ha (6,849 ac). The estimated mean hydraulic retention time was 35.2 days.

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LIST OF ABBREVIATIONS AND ACRONYMS

ac	acre
ac-ft	acre-foot
BMP	Best Management Practices
cm	centimeter
cm d⁻¹	centimeter per day
cfs	cubic foot per second
EAA	Everglades Agricultural Area
ENR	Everglades Nutrient Removal
ET	Evapotranspiration
ft	foot
ha	hectare
ha-m	hectare-meter
HW	Headwater
in	inch
in d⁻¹	inch per day
m	meter
m³s⁻¹	cubic meter per second
MAX	Maximum
mm	millimeter
MIN	Minimum
NGVD	National Geodetic Vertical Datum
P	Phosphorus
Q	Discharge
rpm	Rotation per minute
SFWMD	South Florida Water Management District
STA	Stormwater Treatment Area
TW	Tailwater
UVM	Ultrasonic Velocity meter
WCA	Water Conservation Area

CONVERSION FACTORS

METRIC	ENGLISH
mm	0.03937 in
cm	0.3937 in
m	3.2808 ft
ha	2.47 ac
m ³ s ⁻¹	35.33 cfs
ha-m	8.1068 ac-ft

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INTRODUCTION

Background

The Everglades Nutrient Removal (ENR) Project is a 1,544 hectare (ha) or 3,815 acre (ac) constructed wetland, designed and operated to demonstrate the feasibility of large-scale phosphorus reduction from agricultural runoff/drainage. The project is located in South Florida (26° 38' N, 80° 25' W) at the eastern edge of the Everglades Agricultural Area (Figure 1). The Everglades Agricultural Area (EAA) is a 240,000 ha (593,000 ac) highly productive irrigation/drainage basin with a major production of sugarcane. Ecological changes in the Everglades have been partially attributed to an increase in phosphorus (P) concentrations in the inflow waters. Local, state and federal initiatives have been taken to reduce total phosphorous load from agricultural runoff/drainage. Agricultural runoff/drainage from the agricultural area flows to the south and southeast through four primary canals shown in Figure 1 (Miami, North New River, Hillsboro, West Palm Beach).

A minimum of 25 percent of the total phosphorous load in agricultural runoff/drainage is required to be removed at the farm level through the application of various agricultural Best Management Practices (Whalen and Whalen, 1994). Further removal of P is to be achieved through constructed wetland treatment systems known as Stormwater Treatment Areas (STAs). The ENR is a field scale prototype for the large scale STAs. It is built on farmland owned by the State of Florida and previously leased (until 1988) to Knight's Farm for sugarcane and corn production. Originally, the land was part of the Everglades which consisted of wetland prairies, sloughs and stands of custard apple (Davis, 1943). Construction of the ENR started in August 1992 and was completed in October 1993. The inflow and outflow pumps started operation in August 1994. The ENR was operated for close to five years before becoming part of Stormwater Treatment Area 1 West (STA-1W) at the beginning of July 1999.

Stormwater Treatment Area 1 West is a larger scale constructed wetland, which incorporates the ENR and has a total area of 2,772 hectares (6,849 acres). The ENR was expanded to the north with the addition of Cell 5 (1,228 hectares, 3034 acres) to form STA-1W. The total average design flow volume is 17,621 ha-m (142,853 ac-ft) (SFWMD, 1998). Construction was completed and discharge into Cell 5 started in February of 1999. The ENR was run concurrently until end of June of 1999.

This report has two sections. Section I presents water budget analysis for the ENR covering the last months of the project before it started fully operating as part of STA-1W (August 20, 1998 to June 30, 1999). Water budget analyses for the previous four years of the ENR project (August 19, 1994 to August 19, 1996; August 20, 1996 to August 19, 1997; August 20, 1997 to August 19, 1998) were reported in three South Florida Water Management District Technical Memorandums (SFWMD, 1996; Abtew and Mullen, 1997; Abtew and Downey, 1998). Section II of this report presents the first year water budget for STA-1W (July 1, 1999 to June 30, 2000).

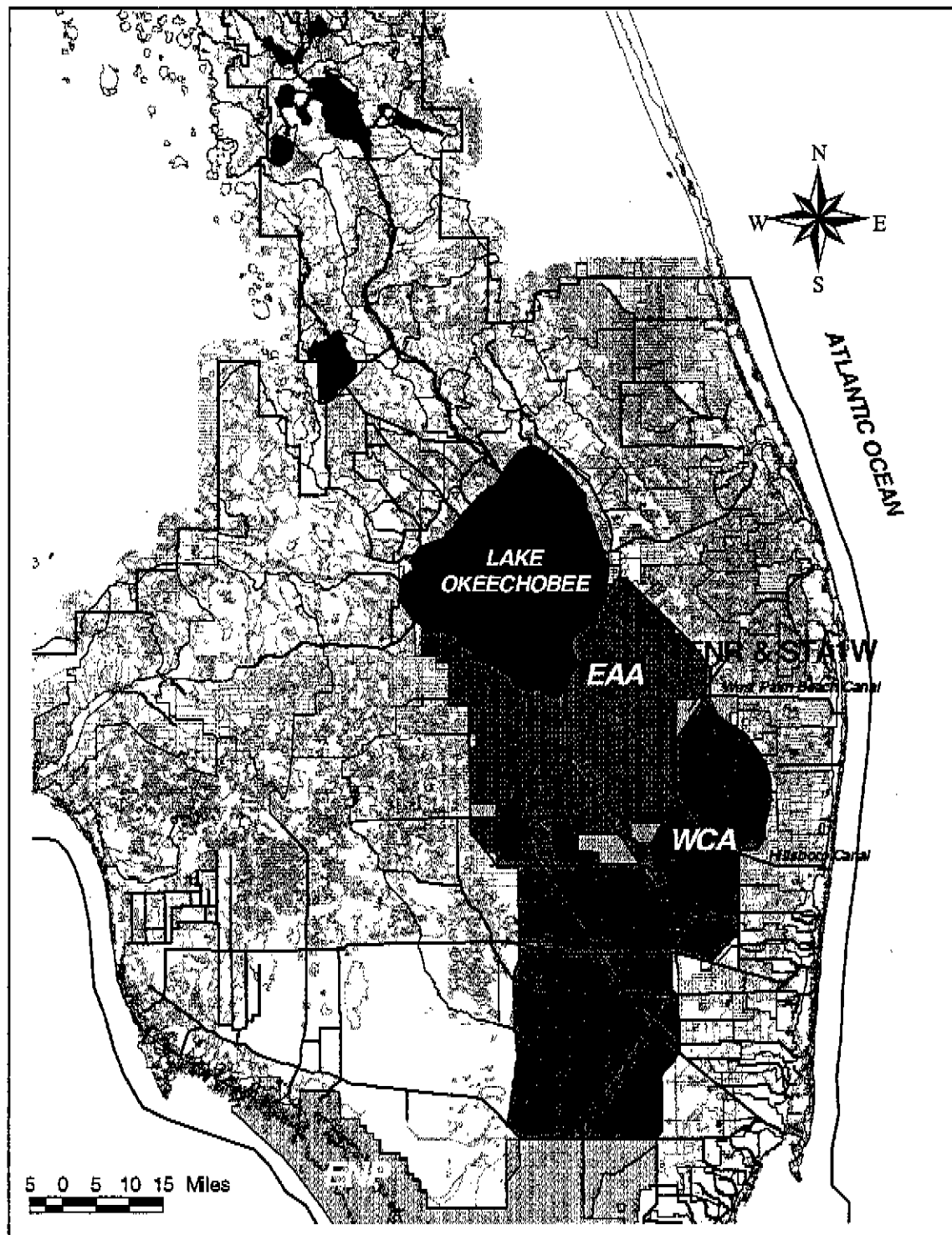


Figure 1. Location of the Everglades Nutrient Removal Project and Stormwater Treatment Area 1 West

SECTION I

EVERGLADES NUTRIENT REMOVAL PROJECT (ENR)

Site Description

The ENR Project area is primarily covered by Okeechobee muck soils with very small topographic relief and an average ground elevation of 3 meters (m) or 9.84 feet (ft) NGVD; a 1 to 2 m layer of peat overlies on several meters of carbonate rock (Jammal and Associates, Inc., 1991). To the east, the L-7 levee separates the ENR Project from the Loxahatchee Wildlife Refuge (Water Conservation Area 1, WCA1). The northern and western sides of the ENR are encompassed by a seepage canal that separates the ENR levee from agricultural fields. The narrow, southern ENR levee runs along Knight's Farm, which currently is not under cultivation. A 12-km (7.5-mile) levee surrounds the ENR and internal levees separate the five interior cells. The Project consists of two parallel treatment trains of two cells each and a buffer (distribution cell). As shown in **Figure 2**, the upper two cells, Cells 1 and 2, are treatment cells. The lower two cells, Cells 3 and 4, are polishing cells. The eastern treatment train carries water from the Buffer Cell to Cell 1, then to Cell 3 and finally to the outflow pump. The western treatment train carries water from the Buffer Cell to Cell 2, then to Cell 4 and finally to the outflow pump. At present, the ENR has been incorporated into STA-1W, which comprises five cells: Cells 1, 2, 3, 4 and 5. Average ground elevation and area for each cell is shown in **Table 1**.

Vegetation Cover and Monitoring

As part of the ENR monitoring plan, temporal and spatial changes of vegetation have been documented using quarterly aerial photography prior to 1995 and semi-annually since 1995. Average vegetation cover for the Buffer Cell and Cells 1, 2, 3, and 4 of the ENR, estimated from an aerial photograph of November 6, 1998 and April 13, 1999 is shown in **Table 1**. The dominant covers are cattail (37%), open water/submerged aquatics (31%), followed by mixed vegetation (19%), algae/macrophyte complex (7%) and floating aquatics (6%).

ENR SYSTEM HYDRAULICS AND OPERATION

System Hydraulics

West Palm Beach canal water that would otherwise be pumped into the Loxahatchee Wildlife Refuge or WCA1 via the S5-A Pump Station was partially diverted to the ENR through five culverts and a 3.4 km (2.1 mile) supply canal. Inflow into the constructed wetland, outflow from the constructed wetland, and seepage recycling are performed with lift pumps. The inflow pump station (G-250) had six identical pumps with a total capacity of 16.98 cubic meters per second ($\text{m}^3 \text{s}^{-1}$) or 600 cubic feet per second (cfs). The inflow pumps lifted water from the delivery canal into the Buffer Cell. The outflow pump station (G-251) had six identical pumps with a total capacity of 12.74 $\text{m}^3 \text{s}^{-1}$ (450 cfs). The outflow pumps lifted treated effluent from the ENR into the Loxahatchee Wildlife Refuge.

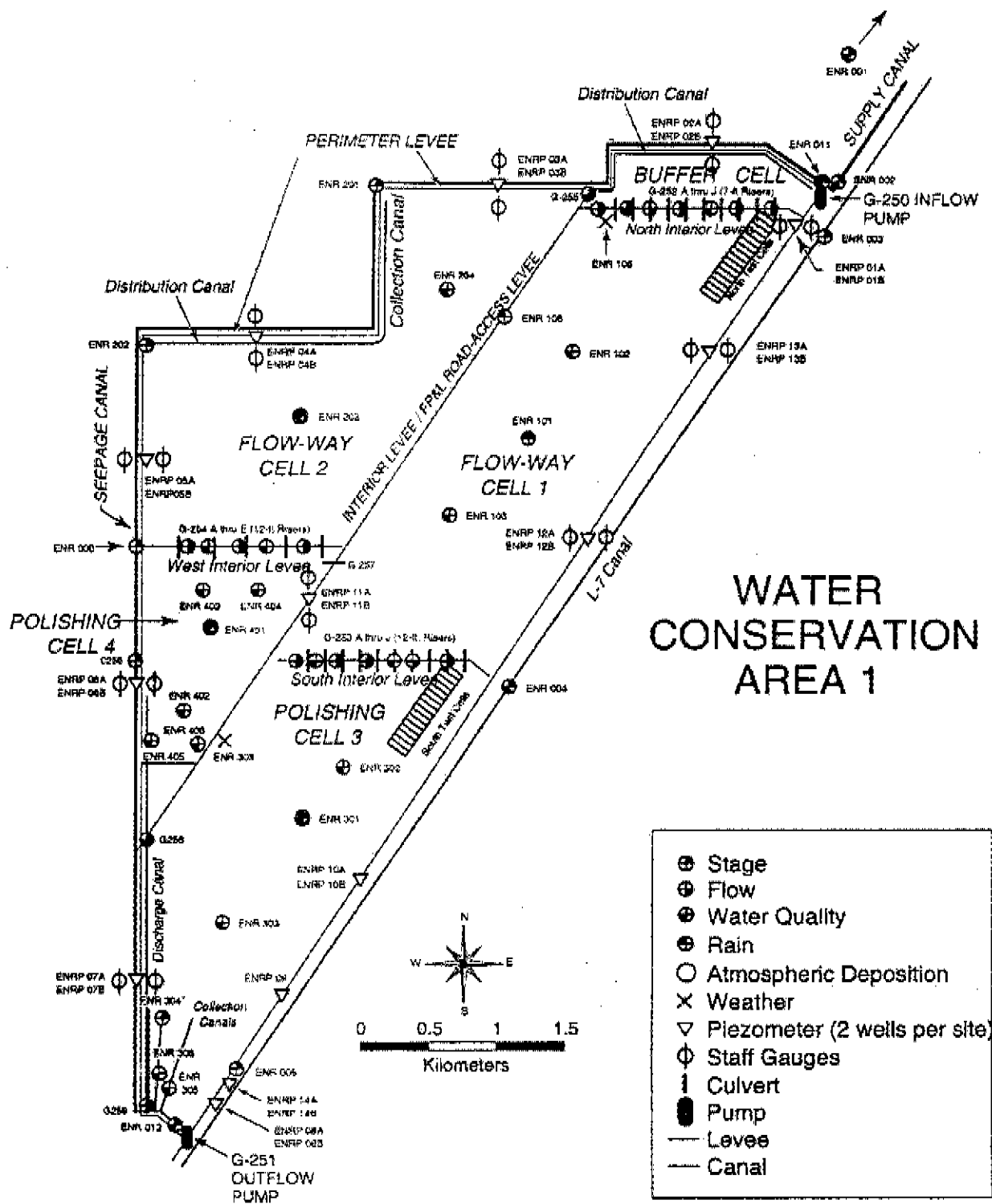


Figure 2. ENR structures and monitoring network

Table 1. Site characteristics of the Everglades Nutrient Removal Project.

Cell	Average Ground Elev.		Land Cover*			
	Area ha (ac)	m (ft) NGVD	Cattails (%)	Algae/Macrophyte complex (%)	Floating aquatics (%)	Mixed veg. (%) Open water/ Submerged aquatics (%)
Buffer	55 (136)	3.10 (10.17)	44	0	43	8 5
Cell 1	525 (1297)	3.13 (10.25)	30	0	5	21 44
Cell 2	414 (1023)	2.94 (9.65)	46	0	9	1 44
Cell 3	404 (998)	3.10 (10.18)	47	0	1	41 11
Cell 4	146 (361)	3.00 (9.83)	5	79	0	1 15
Total	1544 (3815)	3.02 (9.92)*	37	7	6	19 31

* average land cover for ENR (based on November 6, 1998 and April 13, 1999 observations).

area-weighted average ground elevation.

Seepage from the seepage canal was pumped into the Buffer Cell by three identical pumps (G-250S) with a total capacity of $5.66 \text{ m}^3 \text{ s}^{-1}$ (200 cfs). Water surface elevation was monitored by automated stage recorders, and staff gages supplemented stage readings for operation.

As part of the incorporation of the ENR into the larger STA-1W, there were changes to the ENR hydraulic structures and their functions. The old ENR seepage canal was plugged at the end of February 1999 and G-250S quit pumping ENR seepage, as was the case in the previous four years of its operation. The sheet pile that separated the ENR seepage canal from the ENR supply canal was removed in the middle of March 1999. Between March 1999 and the beginning of July 1999, G-250S was used as the main inflow pump to the ENR. Later, three of the pump units from G-250 (original ENR inflow pump) were removed and three pump units remained to supplement G-250S in emergency conditions. Since July 1999, the function of G-250S is to pump seepage from Cell 5 of STA-1W into Cell 1. The current total capacity of the three main pumps is $5.66 \text{ m}^3 \text{ s}^{-1}$ (200cfs) and the three supplemental pumps have total capacity of $8.49 \text{ m}^3 \text{ s}^{-1}$ (300 cfs) for a combined capacity of $14.15 \text{ m}^3 \text{ s}^{-1}$ (500 cfs).

Inter-cell flows are regulated with risers through 16.7 m (55 ft) long and 1.83 m (6 ft) diameter culverts. In the eastern treatment train, water flowed from the Buffer Cell into Cell 1 through ten culverts (G-252A-J) until the beginning of March, 1999 when the seven western side culverts (A through G) were removed and the levee degraded. Water flows from Cell 1 to Cell 3 through ten culverts (G-253A-J). Water from Cell 3 is directed to the outflow pump through collection canals. In the western treatment train, water flowed from the Buffer Cell into Cell 2 through five culverts (G-255A-E) but later two additional 72 inches culverts were added on the southern side as part of STA-1W construction. Water flowed from Cell 2 to Cell 4 through five culverts (G-254A-E) but later four more culverts were added as part of STA-1W construction and naming changed to G-254A, A1, B, B1, C, C1, D, D1 and E. Outflow from Cell 4 moves through five culverts (G-256A-E) into a discharge canal that leads to the outflow pump. Water can be recirculated from Cell 2 and Cell 4 via the seepage canal by being released through culverts (G-258 and G-259, respectively) in the western levee. Water can be transferred from Cell 1 to Cell 4 through culvert G-257 when necessary. Flow through culverts is being monitored with UVMs. ENR structure locations and monitoring network are shown in **Figure 2**. Other hydraulic changes associated with STA-1W construction are presented in Section II.

Operation

Guardo and Kosier (1993) developed a preliminary operation plan for the ENR. Early and late start-up water depths and stages were recommended. The seepage pump started operation in December 1993. Pumping was mainly to recirculate water from the seepage canal and reroute water from cell to cell. The inflow and outflow pumps started operating on August 19, 1994, marking the beginning of full-scale operation of the ENR. Inflow and outflow regulations have been a result of many conditions, such as the stage in each cell, S-5A pump station status, seepage tests, construction operations, pump maintenance and others. Through the five years of operation the mean depth in the Buffer Cell, Cells 1, 2, 3 and 4 was 60 cm (24 in), 50 cm (20 in), 71 cm (28 in), 36 cm (14 in) and 59 cm (23 in), respectively.

ENR HYDROLOGY AND HYDROLOGIC MONITORING

Rainfall

South Florida has a subtropical climate with relatively high rainfall frequency of occurrence and magnitude. On the average, 34% of the annual rainfall occurs in the dry season (November to May), with the remaining 66% occurring in the wet season (June to October). Mean annual rainfall for the area is 133 centimeters (cm) or 52 inches (in) as reported in Abtew and Khanal (1994). Frontal rainfalls occur in the dry season and have relatively lower spatial variation. Rainfall during the wet season is associated with daily convective and tropical systems, which have high spatial variations.

Based on the high variation of summer rainfall observations in the area, a ten-gage rainfall network was established as a pilot network to evaluate the optimum gage density needed for the project area. Network analysis of the first wet season daily rainfall showed that five gages were sufficient for the area (Abtew et al., 1995). As a result, three gages were removed. However, a seven-gage network is maintained because two of the gages are associated with two weather stations, and four gages (one at the middle of each cell) are part of the monitoring network required by the operating permit. On March 4, 1999, station ENR105 was discontinued and currently, there are six raingages. Table 2 lists all the rainfall gaging stations, the corresponding database keys and respective Thiessen weights. Figure 2 shows the gage locations. Areal average rainfall on the project site was computed as a Thiessen-weighted average of the stations. Stations with few instances of data gaps were estimated from the closest gage. The daily distribution of areal average rainfall for the study (August 20, 1998 to June 30, 1999) is depicted by Figure 3. Monthly summary of areal average rainfall for the ENR is shown in Table 3. The total areal average rainfall for ENR (August 20, 1998 to June 30, 1999) was 115.2 cm (45.4 in).

Table 2. Rainfall stations in the ENR, database retrieval keys and Thiessen weights.

Stations	DBKEY	Thiessen Weights	
ENR101	15851	0.160	0.087
ENR105	15861	0.143	-----
ENR106	DU515	0.107	0.441
ENR203	15874	0.183	0.222
ENR301	15877	0.224	0.126
ENR308	15888	0.072	0.049
ENR401	15862	0.111	0.075

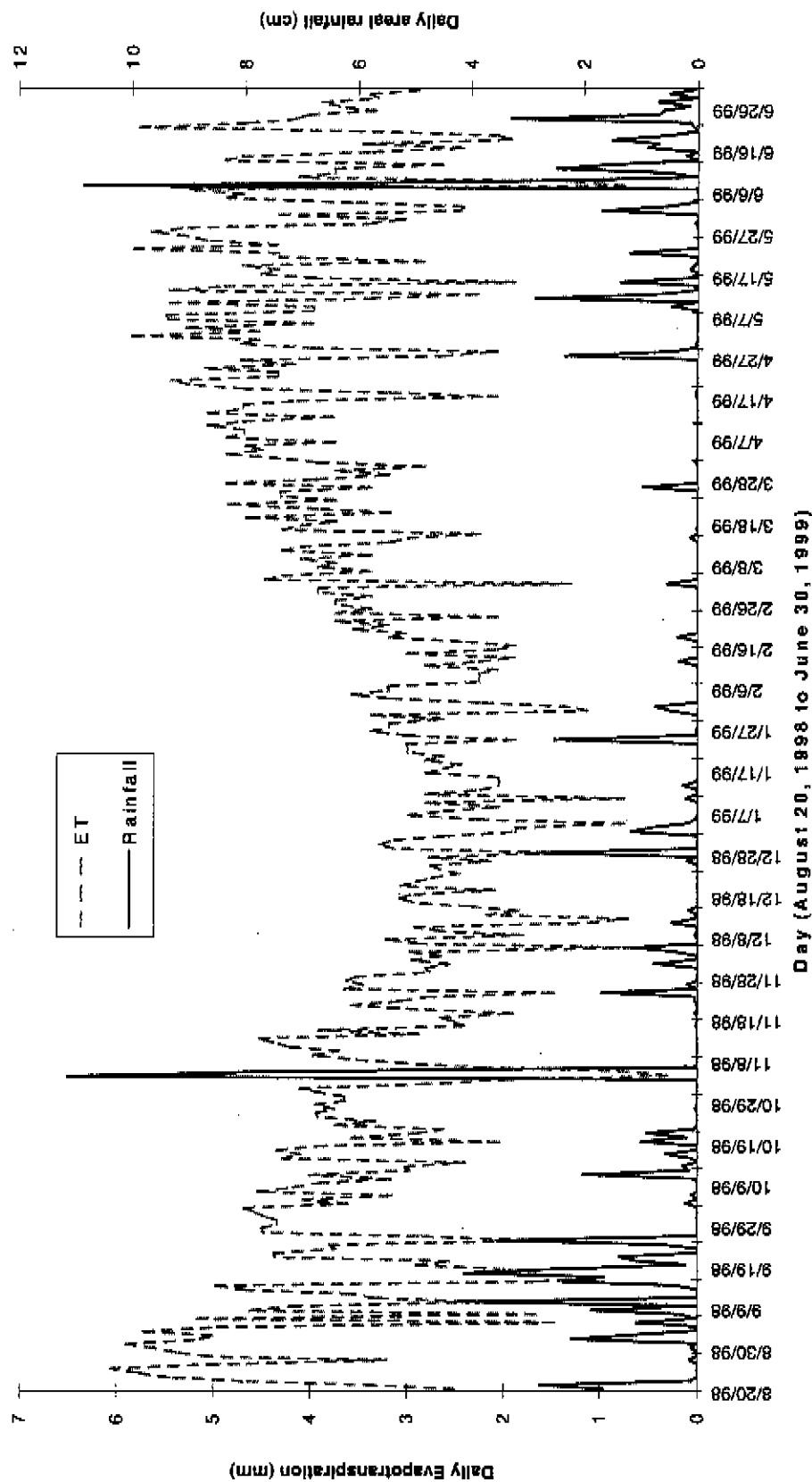


Figure 3. Daily distribution of areal average rainfall and evapotranspiration in the ENR

Table 3. ENR Project monthly flows, areal weighted rainfall and ET (August 20, 1998 to June 30, 1999).

Year	Month	Inflow G-250 ha-m	Outflow G-251 ha-m	Rainfall cm (in)	ET cm (in)	Seepage pump G-250_S ha-m	Seepage L-7 culverts ha-m
1998	Aug*	98	219	4.75 (1.87)	5.80 (2.28)	141	8
1998	Sept	667	725	28.63 (11.27)	10.68 (4.20)	426	50
1998	Oct	1451	859	5.51 (2.17)	11.42 (4.50)	485	55
1998	Nov	707	1358	20.88 (8.22)	8.92 (3.51)	478	103
1998	Dec	558	707	6.10 (2.40)	7.67 (3.02)	395	74
1999	Jan	847	817	5.69 (2.24)	7.57 (2.98)	406	55
1999	Feb	569	701	1.45 (0.57)	7.85 (3.09)	188	33
1999	Mar	276	141	1.65 (0.65)	11.61 (4.57)	0	12
1999	Apr	1252	741	2.95 (1.16)	12.89 (5.07)	0	0
1999	May	659	630	6.76 (2.66)	13.73 (5.41)	0	0
1999	June	536	870	30.81 (12.13)	10.49 (4.13)	0	36

* 12 days

Evapotranspiration

Daily evapotranspiration is computed from high resolution weather data using a radiation-based evapotranspiration estimation model developed from lysimeter studies in the ENR (Abtew, 1996a, 1996b). A complete weather station was located in Cell 1 (ENR105) and another is located in Cell 3 (ENR308). Currently, ENR308 is the only weather station operational as ENR105 was discontinued in early 1999. The daily distribution of evapotranspiration for the ENR for the study period (August 20, 1998 to June 30, 1999) is depicted by **Figure 3**. Monthly summary of evapotranspiration for the ENR is shown in **Table 3**. The total evapotranspiration for ENR (August 20, 1998 to June 30, 1999) was 108.6 cm (42.8 in).

Flows

Database keys for the ENR flow structures and daily stage gages are listed in **Table 4**. Since February 1999, the operation of the ENR has been modified due to the transition to STA-1W. The old ENR seepage canal was plugged at the end of February 1999 and structure G-250S_P no longer pumped ENR seepage. The sheet pile that separated the ENR supply canal from the ENR seepage canal was removed in the middle of March 1999. Between March 1999 and the beginning of July 1999, G-250S_P was used as inflow pump for the ENR.

The total inflow pumping for the 315 days (August 20, 1998 to June 30, 1999) was 7,620 ha-m (61,774 ac-ft) and the total outflow through the outflow pump station was 7,768 ha-m (62,974 ac-ft). G-250S_P started its current operation of pumping seepage and discharge from Cell 5 of STA-1W into the remaining cells (Cells 1, 2, 3 and 4) in July 1999. The daily pumping volumes of the inflow and outflow pumps are shown in **Figure 4**. **Figure 5** shows daily pumping rates of the seepage pump and seepage flow through L-7 levee roadside seepage collection culverts. The L-7 seepage through the roadside culverts was estimated using a regression equation developed from 42 data points. A relationship was developed between the seepage from L-7 through the roadside culverts and the stage rise in WCA 1 above 4.57 m (15 ft) NGVD, and the difference in stages between WCA 1 and the eastern cells of the ENR (Guardo, 1996). The regression had a coefficient of determination (R^2) of 0.93 and a standard error of $0.30 \text{ m}^3 \text{ s}^{-1}$. The equation is given as follows:

$$L7seepage = 0.217 \Delta WCA^{1.311} * \Delta h^{2.025} \quad (1)$$

where L-7 seepage is in $\text{m}^3 \text{ s}^{-1}$; ΔWCA is the rise in stage in WCA 1 above 4.57 m (15 ft) NGVD and Δh is the difference in stage between WCA 1 and the eastern cells of the ENR. The total estimated seepage from L-7 through the roadside culverts was 426 ha-m (3,453 ac-ft). Monthly flow data for the study period are presented in **Table 3**.

Table 4. Flow control structures, stage recorders and database retrieval keys used in the water budget analysis of the ENR.

Station	Description	Location	DBKEY	Remark
G-250_P	Pump	Feeder Canal/Buffer Cell	15847,16222	inflow
G-250S_P	Pump	Seepage Canal/Buffer Cell	15846, JK278	seepage return, Inflow
G-251_P	Pump	Cell 4/WCA 1	15848	outflow
G-258_C	Culvert	Cell 3/Seepage Canal	15940	recycle
G-259_C	Culvert	Cell 4/Seepage Canal	15939	recycle
G-251_T	Stage	G-251_P tailwater	16219	WCA1
G-255_H	Stage	Buffer Cell/Cell 2	15908	headwater
ENR101	Stage	Cell 1	15850	center of cell
G-253EF_H	Stage	Cell 1/Cell 3	15897	headwater
G-255_T	Stage	Buffer Cell/Cell 2	15909	headwater
ENR203	Stage	Cell 2	15873	center
G-254C_H	Stage	Cell 2/Cell 4	15903	headwater
G-253EF_T	Stage	Cell 1/Cell 3	15898	tailwater
ENR301	Stage	Cell 3	15876	center
ENR012	Stage	Cell 3	15849	upstream of G-251_P
G-254C_T	Stage	Cell 2/Cell 4	15904	tailwater
ENR401	Stage	Cell 4	15727	center of cell
G-256_H	Stage	Cell 4B/Discharge Canal	15910	headwater
ENR003	Stage	East end of Buffer Cell	15812	WCA1 (discontinued 5/7/99)
ENR004	Stage	L7 canal at junction of ENR	15842	WCA1 (discontinued 5/7/99)
ENR005	Stage	L7 canal near G-251	15843	WCA1 (discontinued 5/7/99)

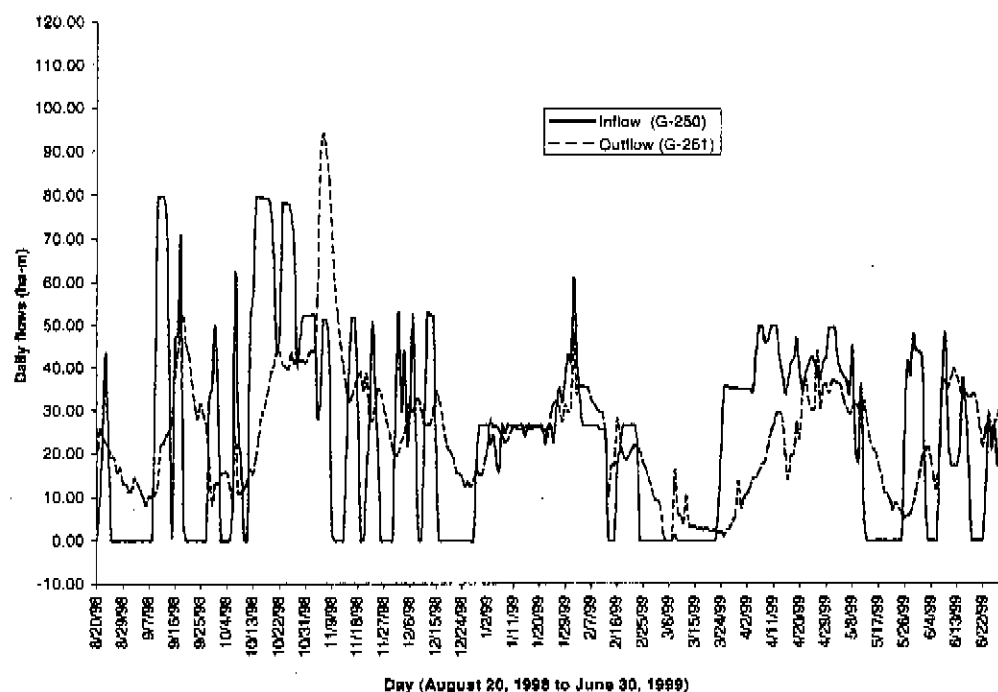


Figure 4. Daily pumping rates of inflow and outflow pumps in ENR

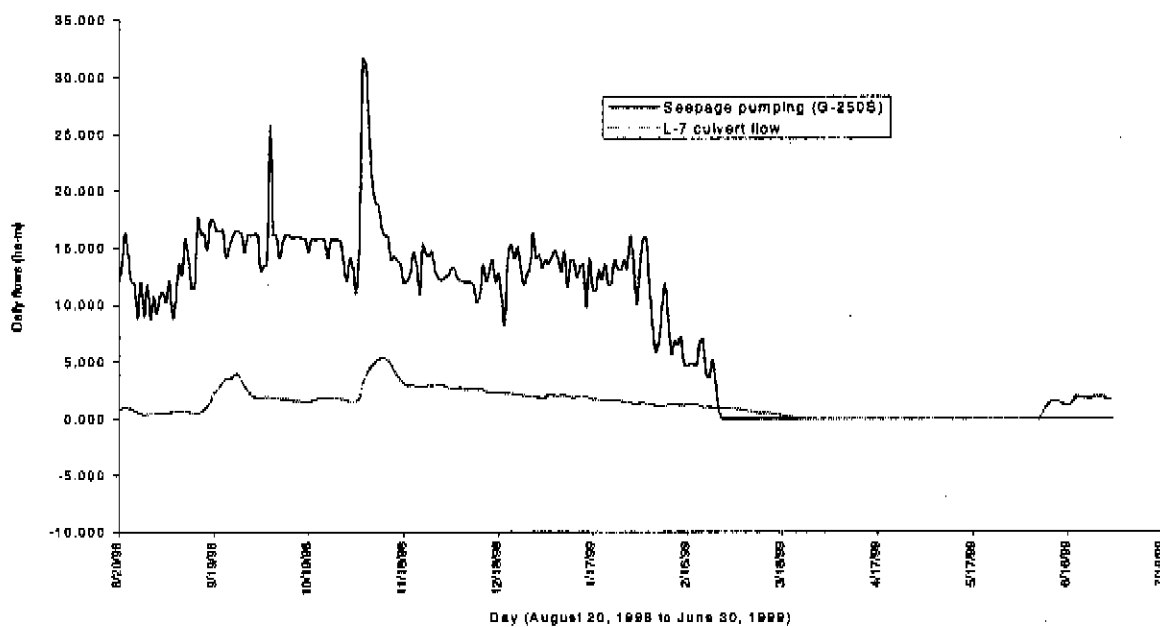


Figure 5. Daily pumping rates of the seepage pump and seepage flow through L-7 levee roadside seepage collection culverts in ENR

Water Levels

Daily water levels in each cell of the ENR are dependent on rainfall, evapotranspiration, seepage and daily operational decisions. Water levels have been regulated based on water depth, operation status of the S-5A pump station, pump maintenance, and other activities in ENR such as dye studies and construction operations. The minimum, maximum, and mean of the daily average stage observations for the study period are shown in **Table 5**. The mean observed stage in the Buffer Cell was 3.62 m (11.88 ft) NGVD. The mean stage in Cell 1 was 3.58 m (11.75 ft) and the mean stage in Cell 2 was 3.59 m (11.78 ft) NGVD. The mean stage in Cell 3 was 3.44 m (11.29 ft) NGVD and the mean stage in Cell 4 was 3.55 m (11.65 ft) NGVD. Average daily water level observations in the eastern treatment train of the ENR are shown in **Figure 6**, while those in the western treatment train are shown in **Figure 7**. The mean water depths for ENR cells, Buffer Cell, Cell 1, Cell 2, Cell 3 and Cell 4 were 52 cm (20.5 in), 45 cm (17.7 in), 65 cm (25.6 in), 34 cm (13.4 in) and 55 cm (21.7 in), respectively.

Table 5. Observed water surface elevations and depths in the ENR (August 20, 1998 to June 30, 1999).

Cell	Water Surface Elevation			Depth
	Min. m (ft) NGVD	Max. m (ft) NGVD	Mean m (ft) NGVD	Mean cm (in)
Buffer	3.33 (10.93)	3.94 (12.93)	3.62 (11.88)	52 (20.5)
Cell 1	3.34 (10.96)	3.92 (12.86)	3.58 (11.75)	45 (17.7)
Cell 2	3.31 (10.86)	3.92 (12.86)	3.59 (11.78)	65 (25.6)
Cell 3	3.28 (10.76)	3.80 (12.47)	3.44 (11.29)	34 (13.4)
Cell 4	3.29 (10.79)	3.89 (12.76)	3.55 (11.65)	55 (21.7)

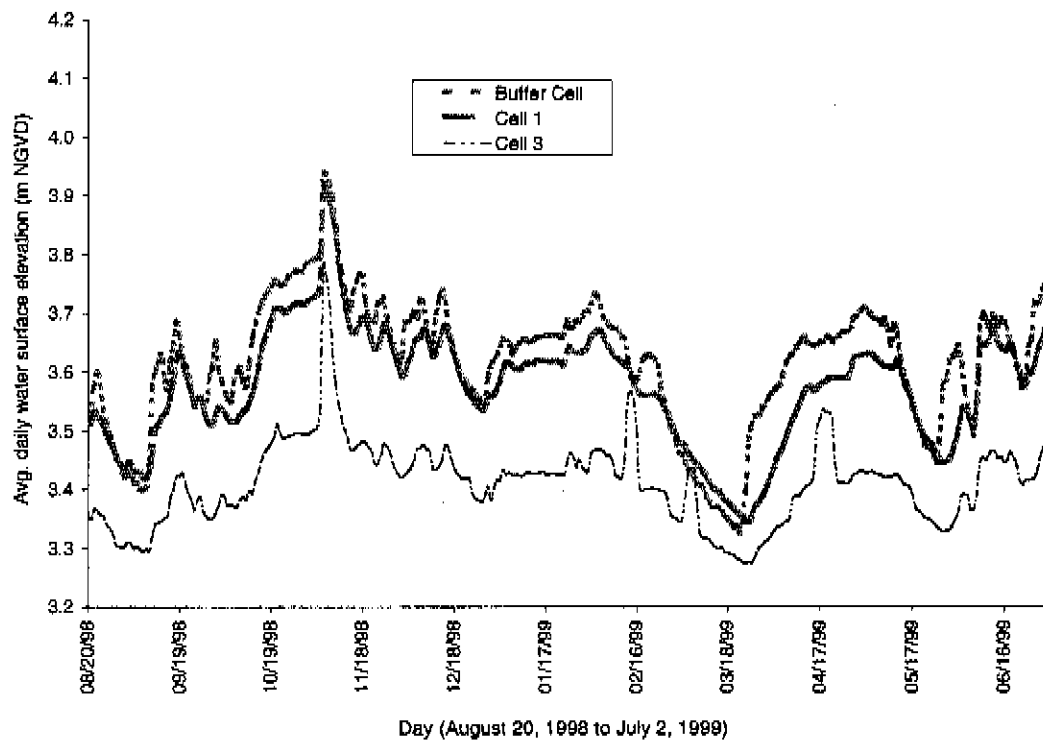


Figure 6. Daily mean water levels in the eastern cells of the ENR and the Buffer Cell

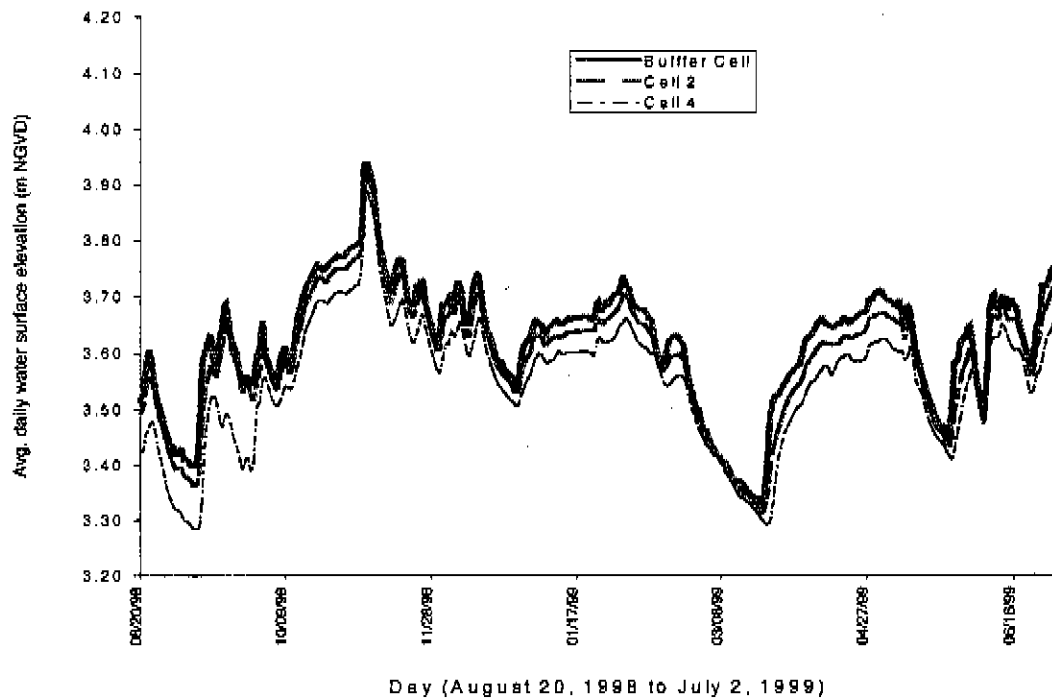


Figure 7. Daily mean water levels in the western cells of the ENR and the Buffer Cell

ENR WATER BUDGET COMPUTATIONS

ENR Water Balance Model

A schematic hydrologic model for the ENR is depicted in **Figure 8**. The influent pumped through the inflow pumps accounts for about 78% of the known inflow to the system. The known inflows to the system are the G-250 and G-250S pump stations inflows, rainfall, and seepage through the roadside L-7 levee culverts (L-7a). From March 1999 to July 1999, G-250S was operated as inflow to ENR. Rainfall accounts for 18% and seepage through the roadside culverts (L-7) accounts for 4%. Outflow pumping (G-251) accounts for 81% of the outflows, with evapotranspiration constituting 18% of the total outflows. The unknowns in the system are subsurface inflows, outflows and errors that account for 1%. The schematic model (**Figure 8**) and the following set of water balance equations represent the hydrologic system of the ENR for water budget analysis purposes:

$$INFLOW - OUTFLOW = \Delta S + \epsilon_T \quad (2)$$

where INFLOW is the amount of water that enters the system from external sources, and OUTFLOW is water that leaves the system boundary and is not recirculated. ΔS is the change in storage in the system during the time interval of interest. Sum of all errors is represented by ϵ_T . Because all inflow and outflow cannot be entirely quantified, the following equation is introduced to represent the remainders, errors and unknowns:

$$REMAINDERS = \epsilon_T + UNKNOWNNS \quad (3)$$

Figure 8 shows the possible inflows and outflows to and from the ENR system. The seepage canal, which encompasses the northern and western sides of the ENR, was designed and operated to capture seepage from the ENR to the neighboring farms.

When opened, and/or through leakage, G-258 and G-259 culverts release water into the seepage canal. Seepage through the western and northern ENR levees is represented in the model by SEEPAGE 2, regardless of the magnitude. SEEPAGE 3 represents the two seepage possibilities into or out of the seepage canal from or to the surrounding farms, regardless of the magnitude. SEEPAGE 1 represents the possible seepage loss through the southern ENR levee into Knight's Farm. The unmeasured seepage flow from WCA 1 into the ENR is represented by L-7b. Researchs on ENR groundwater flow are reported in Guardo and Prymas (1998), and Choi and Harvey (2000). Groundwater mass balance is beyond the scope of this study.

In computing the water balance for the ENR, it is essential to identify quantifiable variables from unquantifiable variables, making reasonable assumptions to reduce the quantity of unknowns as much as possible. Since the purpose of the seepage canal is to recirculate seepage and recycled water, it is assumed that the seepage return pump flows (G-250S) are recirculated in the system as designed. The G-250S ENR seepage recirculation ended in March 1999 as part of STA-1W construction. Seepage recirculation is described or represented in the following equation:

$$S_p = SEEPAGE 2 + \epsilon_R \quad (4)$$

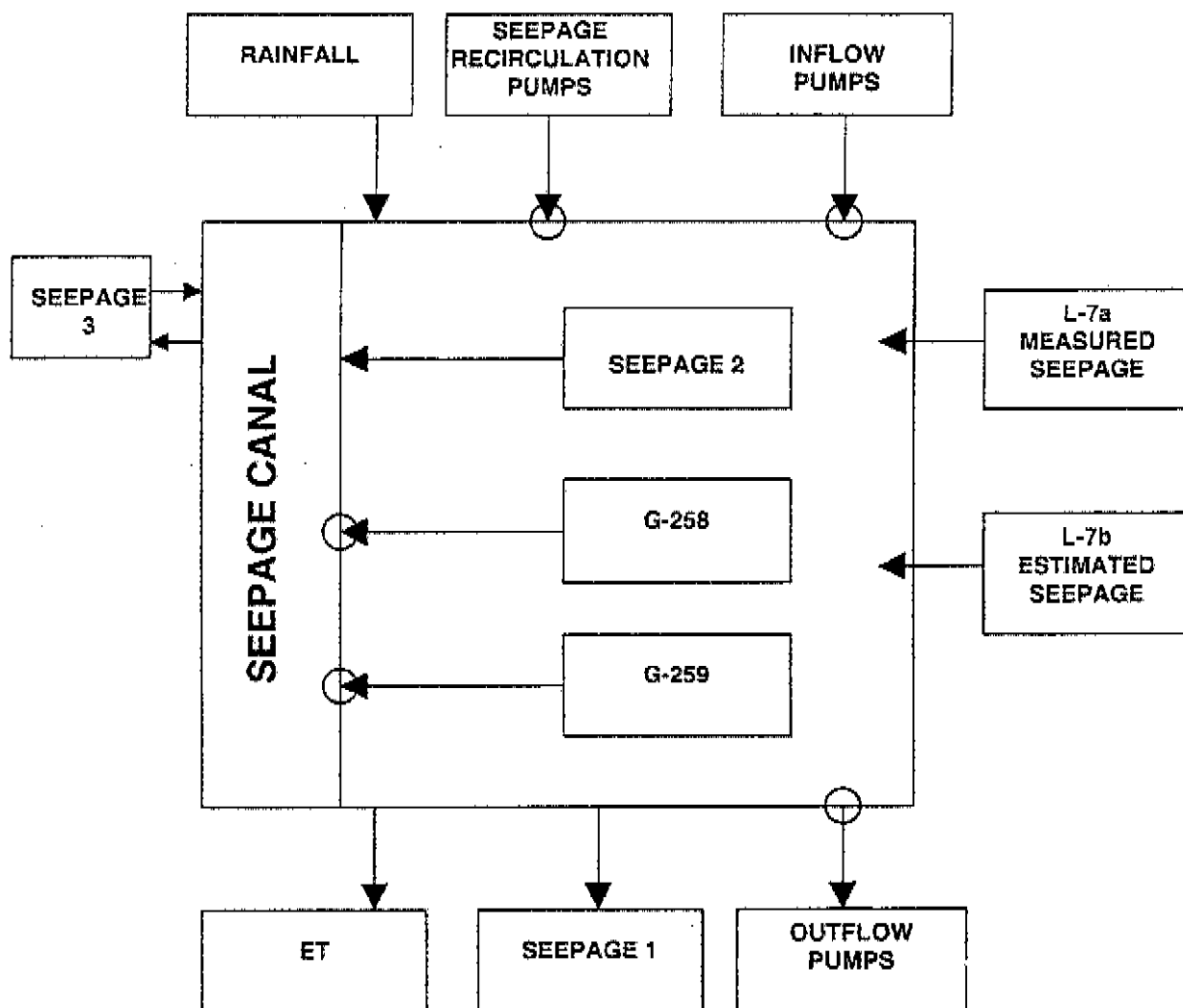


Figure 8. Schematic hydrologic model for the ENR

where S_p is seepage return pump flows (G-250S); SEEPAGE 2 is seepage from ENR to the seepage canal; and ϵ_R is error in assumption and all other errors including measurement errors and calibration errors. The error term also includes the net effect of unknown variable SEEPAGE 3 which is the net subsurface flow of water from the seepage canal to the adjacent farms (west and north) or from the farms to the seepage canal. Also, SEEPAGE 1 (seepage through the southern levee of the ENR) and L-7b (subsurface seepage from WCA 1 that is not captured by the roadside culverts) are also unknowns. Equation 2 is expanded as follows:

$$\Delta S = G250 + R + L7a + L7b - G251 - ET - SEEPAGE\ 1 + \epsilon_R + \epsilon_I + \epsilon_O \quad (5)$$

where ΔS is change in storage in the system; G-250 is inflow pump flows; R is rainfall; L-7a is seepage flows from WCA 1 through the roadside culverts; L-7b is unknown seepage subsurface flow from WCA 1 into the ENR; ET is evapotranspiration losses; SEEPAGE 1 is seepage loss through the southern levee of the ENR; ϵ_R represents errors in accounting for the recirculation water in the system; ϵ_I represents errors in inflow terms; and ϵ_O represents errors in outflow terms. The total error in the system is expressed as follows:

$$\epsilon_T = \epsilon_R + \epsilon_I + \epsilon_O \quad (6)$$

Daily change in storage for the ENR was computed as a sum of storage changes in each of the five cells (Buffer Cell, Cell 1, Cell 2, Cell 3 and Cell 4). Change in storage volume in each cell was computed from the area of the cell and change in stage. Change in stage was computed as the difference between consecutive daily mean stage readings averaged from two or three locations in each cell (Table 5).

The remainders in the computation of daily water balances are the sum of all errors and unknowns in the system. Daily remainders were computed for the study period based on the following equation:

$$REMAINDERS = \epsilon_T + SEEPAGE\ 1 + L7b \quad (7)$$

where ϵ_T is the sum of all errors, SEEPAGE 1 is seepage from the ENR through the southern levee, and L-7b is seepage from WCA 1 into the ENR that is unaccounted for in the water budget.

Discussion

The total inflow through the inflow pump was 7,620 ha-m (61,774 ac-ft) and almost equaled the total outflow through the outflow pump, which was 7,768 ha-m (62,974 ac-ft). Seepage inflow from the L-7 levee through the roadside culverts was 426 ha-m (3,453 ac-ft). There was no flow data indicating flows through culverts G-258 and G-259. The seepage recirculation pump had a total flow of 2,519 ha-m (20,421 ac-ft). Total average areal rainfall for the study period was 115.2 cm (45.4 in) and the total average areal evapotranspiration was 108.6 cm (42.8 in).

For the study period, the mean daily remainders (errors and unknowns) was -0.30 hectare-meters per day (ha-m d^{-1}) or -2.43 acre-feet per day (ac-ft d^{-1}) with the total remainders being -97 ha-m (-786 ac-ft). The standard deviation of the remainders is 20.57 ha-m d^{-1} (167 ac-ft d^{-1}) which signifies high variation. **Figure 9** depicts the daily remainders distribution. The negative remainder indicates that there is an overall outflow from the system through unidentified directions. The remainder is 1% of the inflows or the outflows. Summary of the water budget is shown in **Table 6**. Details of the water balance terms and calculations are shown in **Appendix I**.

The mean hydraulic loading rate for the study period, based on the pump inflow, was 1.57 centimeters per day (cm d^{-1}) or 0.62 inches per day (in d^{-1}). The mean hydraulic retention time was computed as the ratio of the mean-estimated volume of water of the ENR and the average daily outflow pumping rate. The mean estimated volume was computed from the area-weighted (by cell) mean depth of 48.7 cm (19.2 in) and total area of 1544 ha ($3,815$ ac). The estimated mean hydraulic retention time was 30.5 days. Comparison of the current year ENR water budget components and the previous two years is shown in **Table 7**.

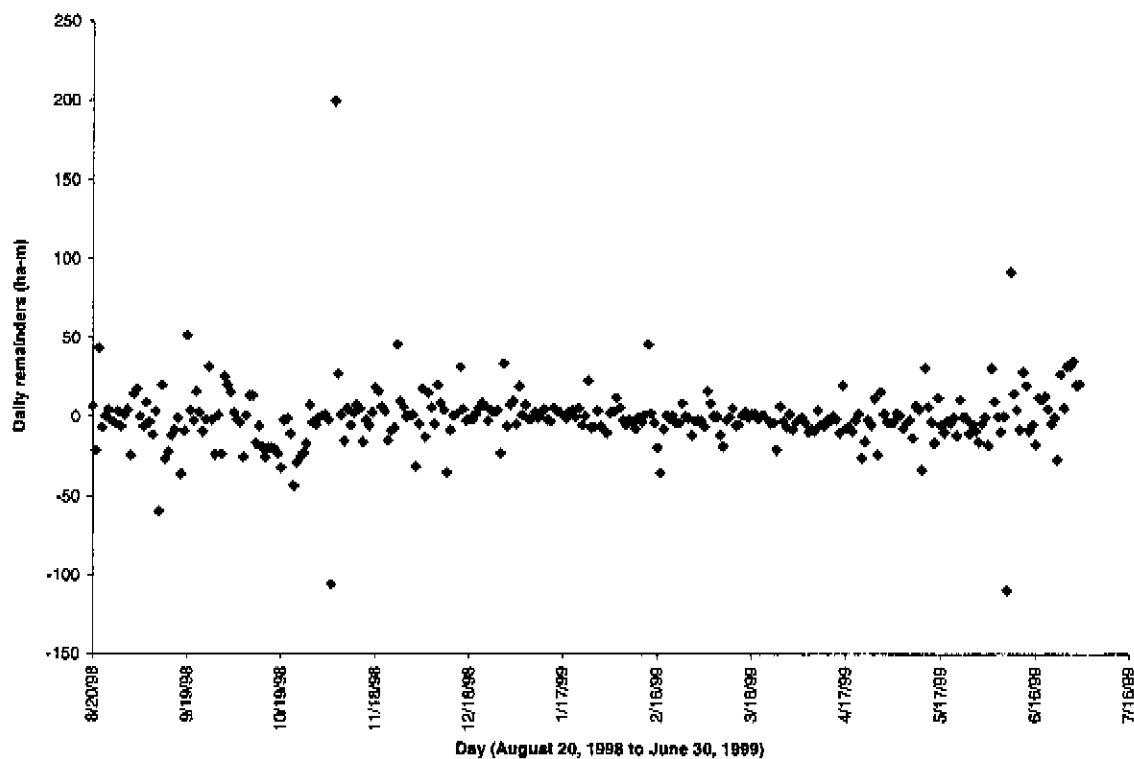


Figure 9. Distribution of daily remainders (errors and unknowns) from the ENR water balance

Table 6. Summary of the water budget of the ENR (August 20, 1998 to June 30, 1999).

INFLOWS	ha-m	Percent of Total	OUTFLOWS	ha-m	Percent of Total
Inflow Pump	7,620	77.6%	Outflow Pump	7,768	81.4%
Rain	1,778	18.1%	ET	1,677	17.6%
L-7 Culverts (L7a)	426	4.3%	Remainders	97	1%
Total	9,824	100%	Total	9,542	100%
Change in Storage	282				

Table 7. Comparison of ENR water budget (1998-1999) components with the previous four years.

	8/19/94 to 8/19/96 (2 years)	8/20/96 to 8/19/97 (1 year)	8/20/97 to 8/19/98 (1 year)	8/20/98 to 6/30/99 (315 days)
INFLOWS (ha-m)				
Inflow pump	39,000	11,972	12,025	7,620
Rain	5,068	2,108	1,938	1,778
L-7 Culverts (L7a)	1,198	431	757	426
Total	45,266	14,511	14,720	9,824
OUTFLOWS (ha-m)				
Outflow pump	38,802	11,872	11,450	7,768
ET	4,050	2,008	2,074	1,677
Remainders	2,781	547	1,349	97
Total	45,633	14,427	14,873	9,542
Change in Storage (ha-m)	-367	83	-153	282
Seepage recirculation				
Seepage pump (ha-m)	7,143	3,385	3,248	2,519
Loading Rate (cm d ⁻¹)	3.45	2.12	2.13	1.57
Average depth (cm)	57.5	52	54.1	48.7
Retention time (days)	17	24.5	25.4	30.5

ENR WATER BUDGET SUMMARY

The ENR was in full operation for five years. This water budget study covers the last year of its operation before being part of STA-1W (August 20, 1998 to June 30, 1999). For the period of analysis, the total inflow through the inflow pump was 7,620 hectare-meters (ha-m) or 61,774 acre-feet (ac-ft) and the total outflow through the outflow pump was 7,768 ha-m (62,974 ac-ft). Seepage inflow from the L-7 levee through the roadside culverts was a total of 426 ha-m (3,453 ac-ft). The seepage recirculation pump had a total flow of 2,519 ha-m (20,421 ac-ft) and there was no flow data indicating flows through culverts G-258 and G-259. Total areal average rainfall for the study period was 115.2 centimeters (cm) or 45.4 inches (in) and the total areal average evapotranspiration was 108.6 cm (42.8 in). The remainders in the water balance, the sum of the errors and unknowns, was 1% of the inflows into the system.

The mean hydraulic loading rate for the one-year period, based on the G-250 pump inflow, was 1.57 centimeters per day (cm d^{-1}) or 0.62 inches per day (in d^{-1}). The loading rate for this study period was lower than previous years. The mean hydraulic retention time was computed as the ratio of the mean estimated volume of water of the ENR and the average daily outflow pumping rate. The mean-estimated volume was computed from the area-weighted (by cell) mean depth of 48.7 cm (19.2. in) and total area of 1544 ha (3,815 ac). The estimated mean hydraulic retention time was 30.5 days.

In the ENR, all hydrologic parameters, with the exception of seepage through the system, are well monitored. Since seepage is not only in one direction, the remainders (errors and unknowns) could not be allocated to one variable.

SECTION II

STORMWATER TREATMENT AREA 1 WEST (STA-1W)

Site Description

The STA-1W project is one of the components of the Everglades Construction Project. It incorporates the ENR and expands northerly with the addition of Cell 5. The total area is 2,772 ha (6,849 acres) with Cell 5 covering 1,228 ha (3,034 acres).

Vegetation Cover and Monitoring

As part of the ENR monitoring plan, temporal and spatial changes of vegetation have been documented using quarterly aerial photography prior to 1995 and semi-annually since 1995. Vegetation cover for Cells 1, 2, 3, and 4 of the ENR estimated from an aerial photograph of April 13, 1999 is shown as vegetation cover estimate for STA-1W (**Table 8**). Based on estimates from aerial photograph, Cell 5 has 55% of emergent and submerged aquatic vegetation and 45% of open water (**Table 8**).

STA-1W SYSTEM HYDRAULICS AND OPERATION

System Hydraulics

STA-1W Inflow and Distribution

West Palm Beach (C-51) canal water that would have been otherwise pumped into the Loxahatchee Wildlife Refuge (WCA1) via the S5-A Pump Station and flow through the refuge is diverted to STA-1W. A small portion of the area of WCA1 near S5A pump station is leveed and forms the STA-1 Inflow and Distribution area (STA-1 I & D) that serves as a storage area to divert water into STA-1W (and into STA-1E when it is built). There are two old and four new water control structures in the STA1 I & D. The S5A pump station delivers water from C-51 (West Palm Beach canal); the S5AS spillway controls inflow and outflow at the junction of L-8 and C-51. The junction has culvert structures S5AW and S5AE. S5AS normally releases water from WCA1 to L-8 canal or vice versa. The four new spillway structures are G-300, G-301, G-302 and G-311.

Table 8. Site characteristics of Stormwater Treatment Area 1 West.

Cell	Area ha (ac)	Average Ground Elev. m (ft) NGVD	Cattails (%)	Algae/Macrophyte complex (%)	Land Cover*		
					Floating aquatics (%)	Mixed veg. (%)	Open water/ Submerged aquatics (%)
Cell 1**	580 (1433)	3.13 (10.25)	30	0	9	22	39
Cell 2	414 (1023)	2.94 (9.65)	46	0	11	2	41
Cell 3	404 (998)	3.10 (10.18)	47	0	1	42	10
Cell 4	146 (361)	3.00 (9.83)	5	78	1	1	15
Cell 5	1228 (3034)	2.90 (9.50)	##	##	##	##	##
Total	2772 (6849)	2.99 (9.79)*	-----	---	—	----	---

* land cover for ENR (based on April 13, 1999 observation); Cell 5 land coverage was based on estimate from aerial photo taken in August 2000

** most of the western levee between old ENR Buffer Cell and Cell 1 is degraded forming a larger Cell 1 (580 ha)

area-weighted average ground elevation

emergent and submerged aquatic vegetation, 55%; open water, 45%

G-300 is a 2-bay reinforced concrete U-shaped spillway with vertical lift gates installed on the crest of an ogee shaped weir. The purpose of this structure is to bypass flows from the STA-1 I & D area into the L-40 borrow canal which runs along the eastern edges of WCA1. G-301 is a 3-bay reinforced concrete U-shaped spillway with vertical lift gates on crest of weir. The purpose of this structure is to bypass flow from the STA-1 I & D area into WCA1 along the L-7 borrow canal on the western edge of WCA1. G-302 is a fixed-crest concrete ogee spillway equipped with two vertical lift gates 6 meters (20 ft) wide each. The purpose of this structure is to supply inflow to the five cells of STA-1W from the STA-1 I & D area and has a capacity of $92 \text{ m}^3 \text{ s}^{-1}$ (3,250 cfs). G-311 is a 3-bay reinforced concrete spillway with lift gates on crest of weir. The purpose of this structure is to supply water for the future STA-1E from the STA-1 I & D area. Information for STA-1W structures is provided in **Table 9**. The monitoring network of STA-1W is shown in **Figure 10**.

STA-1W Internal and Discharge Structures

The Supply Canal to STA-1W is about 2.72 km (1.7 miles) long extending between the inflow structure G-302 and the structure controlling flow into Cells 1, 2, 3, and 4 (G-303). The canal has side slopes of 2.5:1 with bottom width of 18.3 m (60 ft) at elevation -1.52 m (-5 ft), NGVD. Expected velocities in the inflow canal vary between 0.232 m s^{-1} (0.76 ft s⁻¹) and 0.418 m s^{-1} (1.37 ft s⁻¹) (Hutcheon Engineers, 1996). G-303 is a 2-bay ogee spillway equipped with two lift gates of 4.9 m (16 ft) width and with discharge capacity of $50.4 \text{ m}^3 \text{ s}^{-1}$ (1780 cfs). Inflow to Cell 5 is through ten 29.3 m (96 ft) long corrugated metal pipe culverts (G-304A-J). The combined capacity of the inflow culverts (G-304A-J) is $41.6 \text{ m}^3 \text{ s}^{-1}$ (1470 cfs). The Florida Power Line (FPL) levee runs across Cell 5. Twenty-two culverts (G-305A-V) were constructed to deliver water from the eastern part to the western part of the cell. Each of the G-305 culverts is 213 cm (84 inches) in diameter and 27.4 m (90 ft) long with an invert elevation of 1.07 m (3.5 ft) NGVD. Seepage and recirculated water from Cell 5 is pumped through G-250S to Cell 1 through the old ENR Buffer Cell which is now part of Cell 1. G-250S has three main pumps with combined capacity of $5.66 \text{ m}^3 \text{ s}^{-1}$ (200 cfs) and three supplemental pumps from the old ENR inflow pump station G-250 with a combined capacity of $8.49 \text{ m}^3 \text{ s}^{-1}$ (300 cfs).

Outflow from Cell 5 to the discharge canal is through ten corrugated metal pipes of 183 cm (72 inches) diameter and 39.6 m (130 ft) long with a combined discharge capacity of $41.6 \text{ m}^3 \text{ s}^{-1}$ (1470 cfs). During the study period, Cell 5 flow that was released to the discharge canal was recirculated to the other cells (1, 2, 3 and 4) via culverts G-327A, G-327C and the G-250S pump station. G-327A is a gated culvert with 213 cm (84 inches) diameter, 39.6 m (130 ft) length and $2.83 \text{ m}^3 \text{ s}^{-1}$ (100 cfs) discharge capacity. G-327C is a culvert with 39.3 m (129 ft) length and $2.83 \text{ m}^3 \text{ s}^{-1}$ (100 cfs) discharge capacity. STA-1W outflow structures are G-251 and G-310 pump stations. G-251 has six identical pumps with a combined capacity of $12.74 \text{ m}^3 \text{ s}^{-1}$ (450 cfs). During the study period the only outflow from STA-1W was through G-251 as the construction of G-310 was not complete. G-310 is equipped with six pumps of three different capacities with a total capacity of $86 \text{ m}^3 \text{ s}^{-1}$ (3,040 cfs). G-310 has two electric pumps with combined discharge capacity of $5.66 \text{ m}^3 \text{ s}^{-1}$ (200 cfs); two diesel pumps with combined discharge capacity of $26.6 \text{ m}^3 \text{ s}^{-1}$ (940 cfs) and two diesel pumps with combined discharge capacity of $53.8 \text{ m}^3 \text{ s}^{-1}$ (1,900 cfs).

Table 9. Structure information for STA-1W stations.

Station	G-300	G-301	G-302	G-303	G-304	G-306	G-308	G-309	G-327A	G-310	G-251
Type	spillway	spillway	spillway	spillway	culvert	culvert	spillway	spillway	culvert	pump	pump
Units	2	3	2	2	10	10	1	1	1	6	6
Max Q			$92 \text{ m}^3 \text{ s}^{-1}$ (3250 cfs)	$50.4 \text{ m}^3 \text{ s}^{-1}$ (1780 cfs)	$41.6 \text{ m}^3 \text{ s}^{-1}$ (1470 cfs)	$41.6 \text{ m}^3 \text{ s}^{-1}$ (1470 cfs)	$28.3 \text{ m}^3 \text{ s}^{-1}$ (1000 cfs)	$28.3 \text{ m}^3 \text{ s}^{-1}$ (1000 cfs)	$5.7 \text{ m}^3 \text{ s}^{-1}$ (200 cfs)	$86 \text{ m}^3 \text{ s}^{-1}$ (3040 cfs)	$12.7 \text{ m}^3 \text{ s}^{-1}$ (450 cfs)
Min Q	$-28.3 \text{ m}^3 \text{ s}^{-1}$ (-1000 cfs)	$-28.3 \text{ m}^3 \text{ s}^{-1}$ (-1000 cfs)	0	0	0	0	0	0	0	0	0
Design Q			$92 \text{ m}^3 \text{ s}^{-1}$ (3250 cfs)	$50.4 \text{ m}^3 \text{ s}^{-1}$ (1780 cfs)	$41.6 \text{ m}^3 \text{ s}^{-1}$ (1470 cfs)	$41.6 \text{ m}^3 \text{ s}^{-1}$ (1470 cfs)	$15.8 \text{ m}^3 \text{ s}^{-1}$ (560 cfs)	$15.8 \text{ m}^3 \text{ s}^{-1}$ (560 cfs)	$2.83 \text{ m}^3 \text{ s}^{-1}$ (100 cfs)	$86 \text{ m}^3 \text{ s}^{-1}$ (3040 cfs)	$12.7 \text{ m}^3 \text{ s}^{-1}$ (450 cfs)
Design HW	5.79 m (19 ft)	5.79 m (19 ft)	5.49 m (18 ft)	4.79 m (15.7 ft)	4.79 m (15.7 ft)	3.51 m (11.5 ft)	3.58 m (11.75 ft)	3.84 m (12.6 ft)	2.74 m (9 ft)	2.74 m (9 ft)	
Design TW			4.79 m (15.7 ft)	4.41 m (14.46 ft)		2.74 m (9 ft)	2.29 m (7.5 ft)	2.38 m (7.8 ft)	2.65 m (8.7 ft)		
Bypass stage	6.71 m (22 ft)	6.71 m (22 ft)			5.73 m (18.8 ft)	5.73 m (18.8 ft)	5.03 m (16.5 ft)	5.03 m (16.5 ft)	5.33 m (18.8 ft)		
Flow Min. Elevation	3.35 m (11 ft)	2.35 m (7.7 ft)	2.87 m (9.4 ft)		3.43 m 1.52 m (11.25 ft) (5 ft inv)	2.38 m (7.8 ft) inv	2.26 m (7.4 ft)	2.32 m (7.6 ft)	0.15 m (0.5 ft)		
Flow Width	6.1 m (20 ft)	6.71 m (22 ft)	6.1 m (20 ft)	4.88 m (16 ft)	1.83 m (6 ft) dia.	1.83 m (6 ft) dia.	4.27 m (14 ft)	4.27 m (14 ft)	2.13 m (7 ft) dia.		0.91 m (3 ft) dia.
Flow Height	2.56 m (8.4 ft)	3.57 m (11.7 ft)					2.04 m (6.7 ft)	2.04 m (6.7 ft)			
RPM										720	200

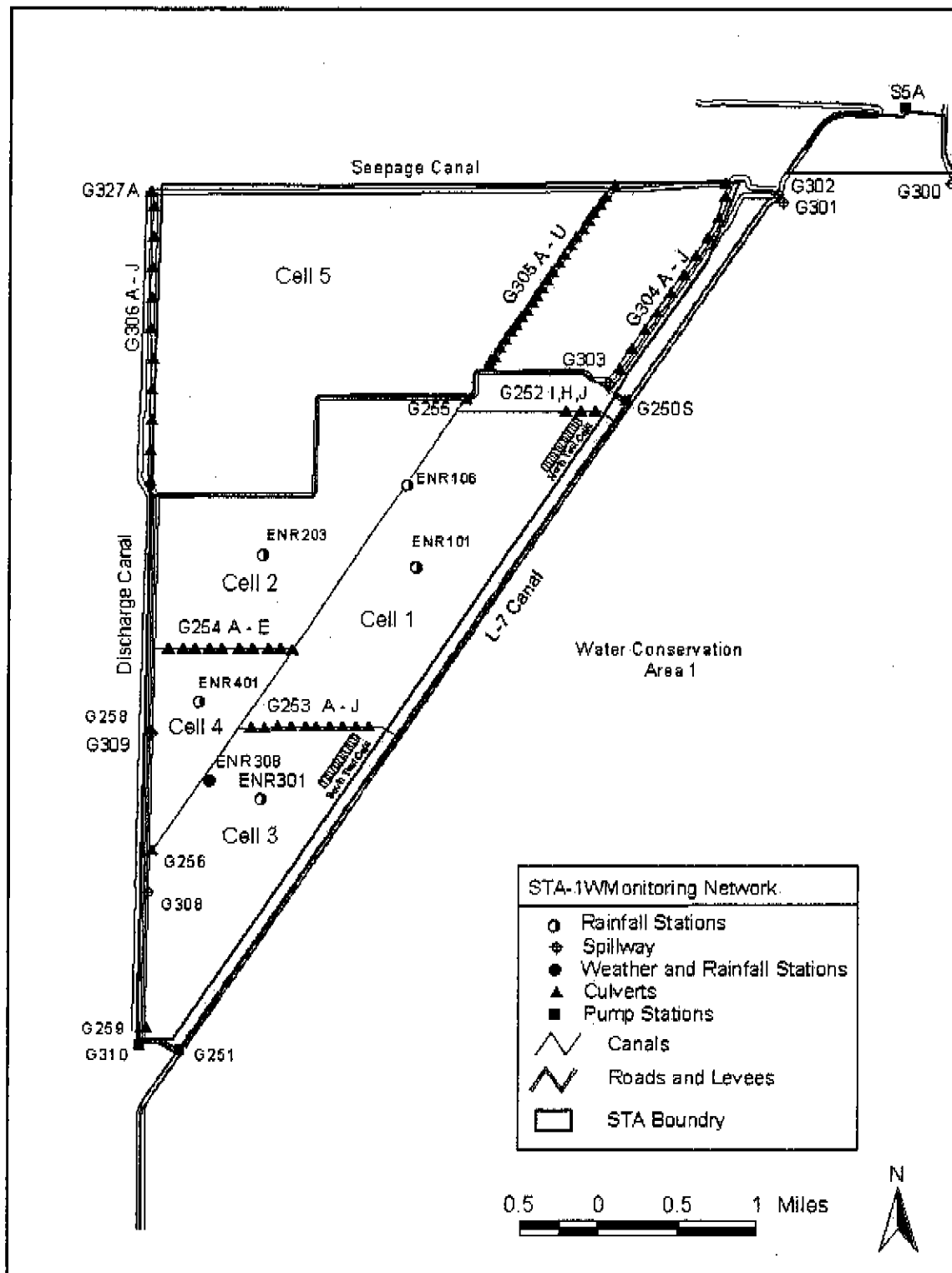


Figure 10. STA-1W structures and monitoring network

Discharge from Cell 1 into Cell 3 flows through ten 183 cm (72 inches) diameter and 17.7 m (58-ft) long culverts (G-253A-J). Discharge from Cell 2 into Cell 4 flows through nine 183 cm (72 inches) diameter and 16.5 m (54 ft) long culverts (G-252A, A1, B, B1, C, C1, D, D1 and E). Discharge from Cell 3 is to the discharge canal through G-308 and G-259 and to WCA1 through G-251 pump station. G-308 is a gated weir with discharge capacity of $15.85 \text{ m}^3 \text{ s}^{-1}$ (560 cfs) and G-259 is a gated culvert of 183 cm (72 inches) diameter and 23.9 m (78.5 ft) long. Discharge from Cell 4 is into the discharge canal and into Cell 3 through G-309, G-258 and G-256A-E. G-309 is a gated weir with discharge capacity of $15.85 \text{ m}^3 \text{ s}^{-1}$ (560 cfs) and G-258 is a gated culvert of 183 cm (72 inches) diameter and 23.5 m (77 ft) long. G-256A-E consists of five culverts of 183 cm (72 inches) diameter and 16.6 m (54.5 ft) length.

The outflow canal extends between G-327A at the northwest corner and G-310 pump station at the southwestern corner. The discharge canal is about 9.12 km (5.7 miles) long with bottom width varying from 15.2 m (50 ft) at G-327A to 24.4 m (80 ft) at G-308 and to 30.5 m (100 ft) at G-259 in order to account for changes in flow magnitude and ground elevation.

Operation

S5A diverts water from the West Palm Beach canal into the STA-1 Inflow and Distribution (STA-1 I&D) area. From the STA-1 I & D area, water flows to STA-1W through spillway G-302 or can be bypassed to WCA1 through G-300 and G-301 when the need arises. Water flows into Cell 5 via the Inflow Canal and through culverts G-304 A-J, and into treatment Cells 1, 2, 3 and 4 through gated weir structure G-303. The old ENR seepage pumps (G-250S) control stages in the seepage canal north of Treatment Cell 5 and redirect flow to the old ENR (Cells 1, 2, 3 and 4). Outflow from STA-1W was through pump station G-251, as pump station G-310 was not completed. One objective of operation was maintaining stage in Cell 5 at 3.41 m (11.2 ft) NGVD with a fluctuation of 0.06 m (0.2 ft).

Transitional Operation of Cell 5

During the transition period from ENR to STA-1W, Cell 5 was maintained full with flows through G-302, while the remaining four cells were operated according to the operation plan described in Section I. During that period, water delivery to the ENR came from the West Palm Beach Canal, through the supply canal and pump G-250 until July 1999. Culverts were installed for flow delivery across G-302 connecting two segments of the supply canal. After the seepage canal was completed and connected to G-250S, the seepage from Cell 5 was returned into the existing ENR treatment Cells 1, 2, 3 and 4 via the culvert under G-302 and through the seepage pumps G-250S.

STA-1W HYDROLOGY AND HYDROLOGIC MONITORING

Rainfall

STA-1W has a six-gauge rainfall network. **Table 10** lists all the rainfall gaging stations, the corresponding database keys and respective Thiessen weights. **Figure 10** shows the gage locations. Areal average rainfall on the project site was computed as a Thiessen-weighted average of the six-gage network. The few instances of data gaps at some of the stations were filled by estimating the rainfall from the closest gage. The daily distribution of areal average rainfall for the study period (July 1, 1999 to June 30, 2000) is depicted in **Figure 11**. Monthly summary of areal average rainfall for the STA-1W is shown in **Table 11**. The total areal average rainfall for STA-1W (July 1, 1999 to June 30, 2000) was 100.8 cm (39.7 in). The annual rainfall was below the average rainfall for the area. The average areal rainfall for the constructed wetland from August 19, 1994 to August 20, 1999 was 144.3 cm (56.8 inches).

Table 10. Rainfall stations in STA-1W, database retrieval keys and Thiessen weights.

Stations	DBKEY	Thiessen Weights
ENR101	15851	0.087
ENR106	DU515	0.441
ENR203	15874	0.222
ENR301	15877	0.126
ENR308	15888	0.049
ENR401	15862	0.075

Evapotranspiration

Daily evapotranspiration is computed from high resolution weather data using a radiation-based evapotranspiration estimation model that was based on lysimeter studies in the ENR (Abtew, 1996a, 1996b). A complete weather station is located in Cell 3 (ENR308). The daily distribution of evapotranspiration for STA-1W for the study (July 1, 1999 to June 30, 2000) is depicted in **Figure 11**. Monthly summary of evapotranspiration for STA-1W is shown in **Table 11**. The total evapotranspiration for STA-1W (July 1, 1999 to June 30, 2000) was 137.6 cm (54.2 inches). The high ET is a reflection of the drier than normal rainfall conditions. The five-year (August 19, 1994 to August 20, 1999) average ET for the ENR was 131.3 cm (51.7 inches).

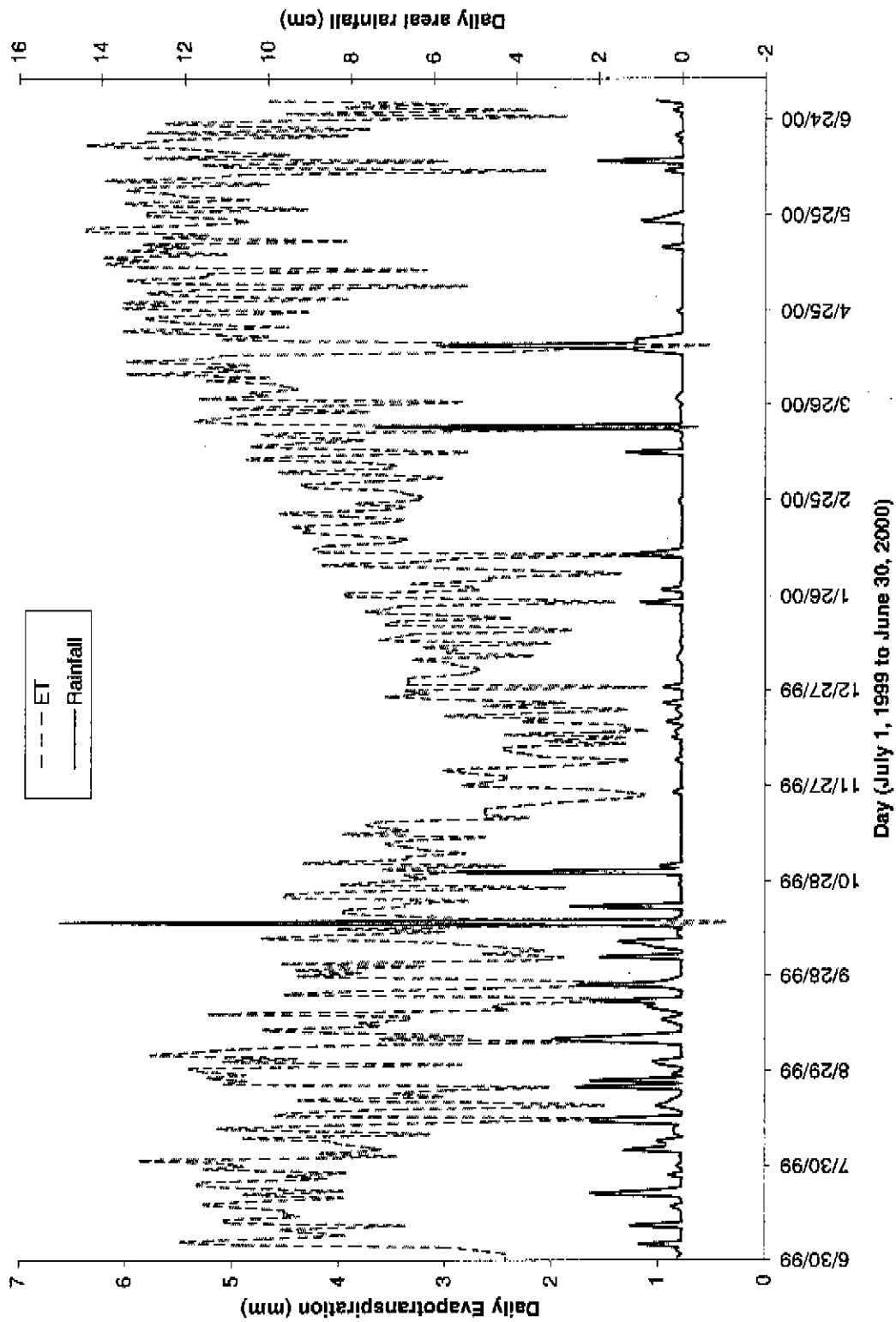


Figure 11. Daily distribution of areal average rainfall and evapotranspiration in STA-1W

Table 11. STA-1W monthly flows, areal weighted rainfall and ET (July 1, 1999 to June 30, 2000).

Year	Month	Inflow G-302_S ha-m	Outflow G-251 ha-m	Rainfall cm (in)	ET cm (in)	Seepage and recirculation pump G-250_S + G-250_P ha-m	Seepage L-7 culverts ha-m
1999	July	11	541	6.43 (2.53)	13.61 (5.36)	118	28
1999	Aug	0	490	14.50 (5.7)	12 (4.73)	628	21
1999	Sept	2413	2015	15.62 (6.15)	10.54 (4.15)	340	30
1999	Oct	2018	2323	30.80 (12.13)	9.70 (3.82)	303	102
1999	Nov	1194	1320	0.87 (0.34)	8.39 (3.30)	425	79
1999	Dec	1606	1539	2.19 (0.86)	6.95 (2.74)	529	53
2000	Jan	2194	1574	1.92 (0.76)	9.11 (3.59)	753	36
2000	Feb	422	1026	2.04 (0.80)	10.02 (3.94)	920	31
2000	Mar	1759	1196	9.47 (3.73)	12.49 (4.92)	737	21
2000	Apr	1386	1355	11.05 (4.35)	14.26 (5.61)	756	30
2000	May	1038	1406	2.28 (0.90)	16.58 (6.53)	722	7
2000	June	595	192	3.61 (1.42)	13.98 (5.50)	457	0

Flows

Database keys for STA-1W flow structures and stage gages are listed in **Table 12**. The total inflow spillway discharge for the study period (July 1, 1999 to June 30, 2000), was 14,636 ha-m (118,651 ac-ft) and the total outflow through the outflow pump station was 14,977 ha-m (121,416 ac-ft). G-250S_P started its current operation of pumping seepage and discharge from Cell 5 of STA-1W into the remaining cells (Cells 1, 2, 3 and 4). The daily pumping rates of the inflow and outflow pumps are shown in **Figure 12**. **Figure 13** shows estimated seepage from the L-7 levee flowing through the roadside culverts and the daily seepage recycling pumping. The total seepage and recirculation pumping was 6,688 ha-m (54,218 ac-ft). The L-7 seepage through the roadside culverts was estimated using a regression equation developed from 42 data points. A relationship was developed between the seepage from L-7 through the roadside culverts and the stage rise in WCA 1 above 4.57 m (15 ft) NGVD, and the difference in stages between WCA 1 and the eastern cells of the ENR (Guardo, 1996). The regression had a coefficient of determination (R^2) of 0.93 and a standard error of $0.30 \text{ m}^3 \text{ s}^{-1}$ (Equation 1). The total estimated seepage from L-7 through the roadside culverts was 438 ha-m (3,551 ac-ft). Monthly flow data for the study period are presented in **Table 11**.

Water Levels

Daily water levels in each cell of STA-1W depend on rainfall, evapotranspiration, seepage and daily operational decisions. Water levels have been regulated based on water depth, operation status of the S5A pump station, pump maintenance and construction. The minimum, maximum, and mean of the daily average stage observations for the study period are shown in **Table 13**. The mean observed stage in Cell 1 was 3.70 m (12.14 ft) NGVD. The mean stage in Cell 2 was 3.71 m (12.17 ft) and the mean stage in Cell 3 was 3.48 m (11.42 ft) NGVD. The mean stage in Cell 4 was 3.65 m (11.98 ft) NGVD and the mean stage in Cell 5 was 3.34 m (10.96 ft) NGVD. Average daily stages for Cell 5 were computed from manual stage readings for G-304 tailwater, G-305 headwater, and G-306 headwater from operation archive data and hardcopies from construction site. Daily data are shown in **Appendix II**. Average daily water level observations in the eastern treatment train of STA-1W are shown in **Figure 14**, while those in the western treatment train are shown in **Figure 15**. **Figure 16** shows daily water levels for Cell 5 during the transitional and operation stages of STA-1W. The mean water depths for Cells 1, 2, 3, 4 and 5 were 57 cm (22.4 in), 77 cm (30.3 in), 38 cm (15 in), 65 cm (25.6 in) and 44 cm (17.3 in), respectively.

Table 12. Flow control structures, stage recorders and database retrieval keys used in the water budget analysis for STA-1W.

Station	Description	Location	DBKEY	Remark
G-302	Spillway	I&D/Supply Canal	JW221	inflow
G-250S_P	Pump	Seepage Canal/Cell 1	JK278	seepage return, recirculation
G-251_P	Pump	Cell 4/WCA 1	JW222	outflow
G-252U_T	Stage	Old Buffer Cell/Cell1	15894	tailwater
ENR101	Stage	Cell 1	15850	center of cell
G-253EF_H	Stage	Cell 1/Cell 3	15897	headwater
G-255_T	Stage	Buffer Cell/Cell 2	15909	headwater
ENR203	Stage	Cell 2	15873	center
G-254C_H	Stage	Cell 2/Cell 4	15903	headwater
G-253EF_T	Stage	Cell 1/Cell 3	15898	tailwater
ENR301	Stage	Cell 3	15876	center
ENR012	Stage	Cell 3	15849	upstream of G-251_P
G-254C_T	Stage	Cell 2/Cell 4	15904	tailwater
ENR401	Stage	Cell 4	15727	center of cell
G-256_H	Stage	Cell 4B/Discharge Canal	15910	headwater
G-304E_T	Stage	Supply Canal/Cell 5	L9842	tailwater
G-304J_T	Stage	Supply Canal/Cell 5	L9843	tailwater
G-306A_H	Stage	Cell 5/discharge Canal	L9951	headwater
G-306J_H	Stage	Cell 5/discharge Canal	L9954	headwater
G-251_T	Stage	G-251_P tailwater	16219	WCAI

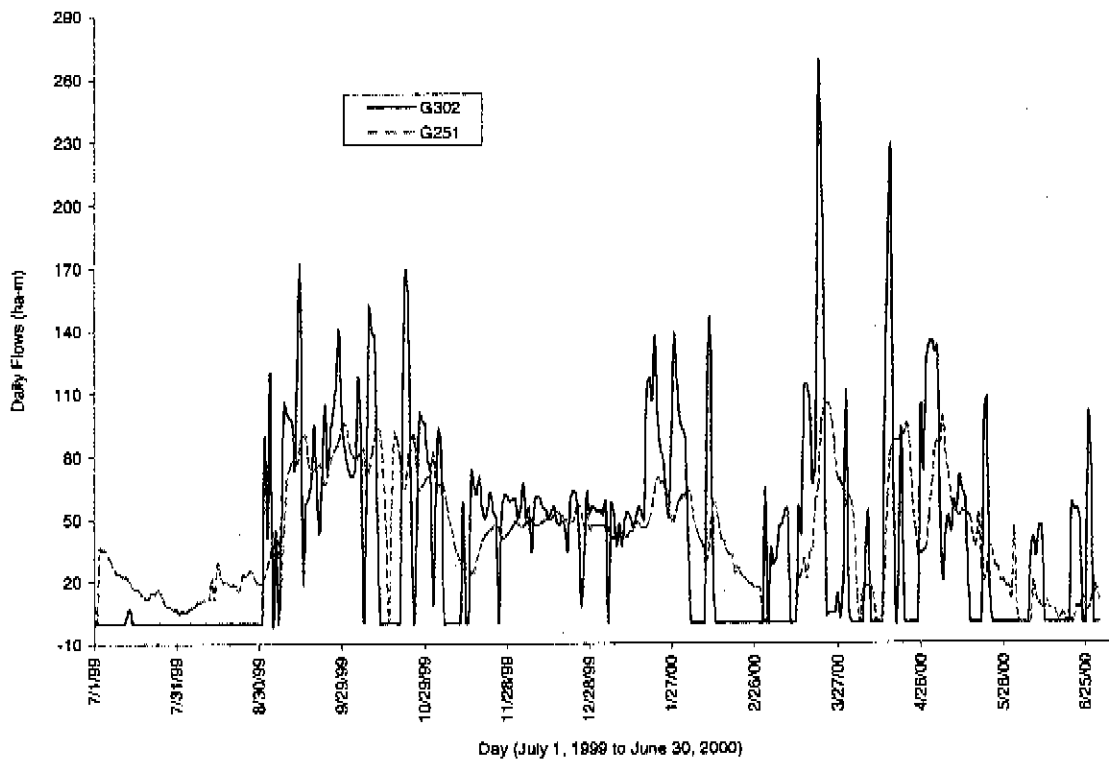


Figure 12. Daily STA-1W inflows and outflows

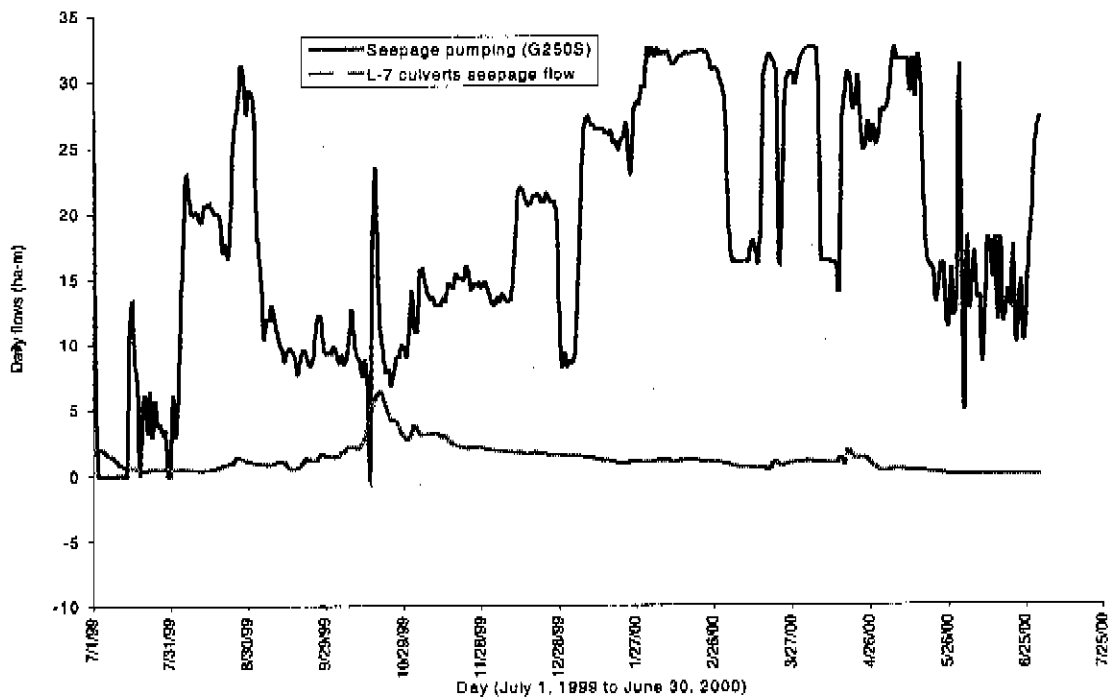


Figure 13. Daily pumping rates of the seepage/recirculation pump and seepage flow through L-7 levee roadside seepage collection culverts in STA-1W

Table 13. Observed water surface elevations and depths in STA-1W (July 1, 1999 to June 30, 2000).

Cell	Water Surface Elevation			Depth
	Min. m (ft) NGVD	Max. m (ft) NGVD	Mean m (ft) NGVD	Mean cm (in)
Cell 1	3.40 (11.14)	4.11 (13.48)	3.70 (12.14)	57 (22.4)
Cell 2	3.43 (11.26)	4.10 (13.45)	3.71 (12.17)	77 (30.3)
Cell 3	3.26 (10.70)	3.99 (13.09)	3.48 (11.42)	38 (15.0)
Cell 4	3.33 (10.93)	4.06 (13.32)	3.65 (11.98)	65 (25.6)
Cell 5*	3.07 (10.07)	3.81 (12.50)	3.34 (10.96)	44 (17.3)

* estimated from operation and construction site records

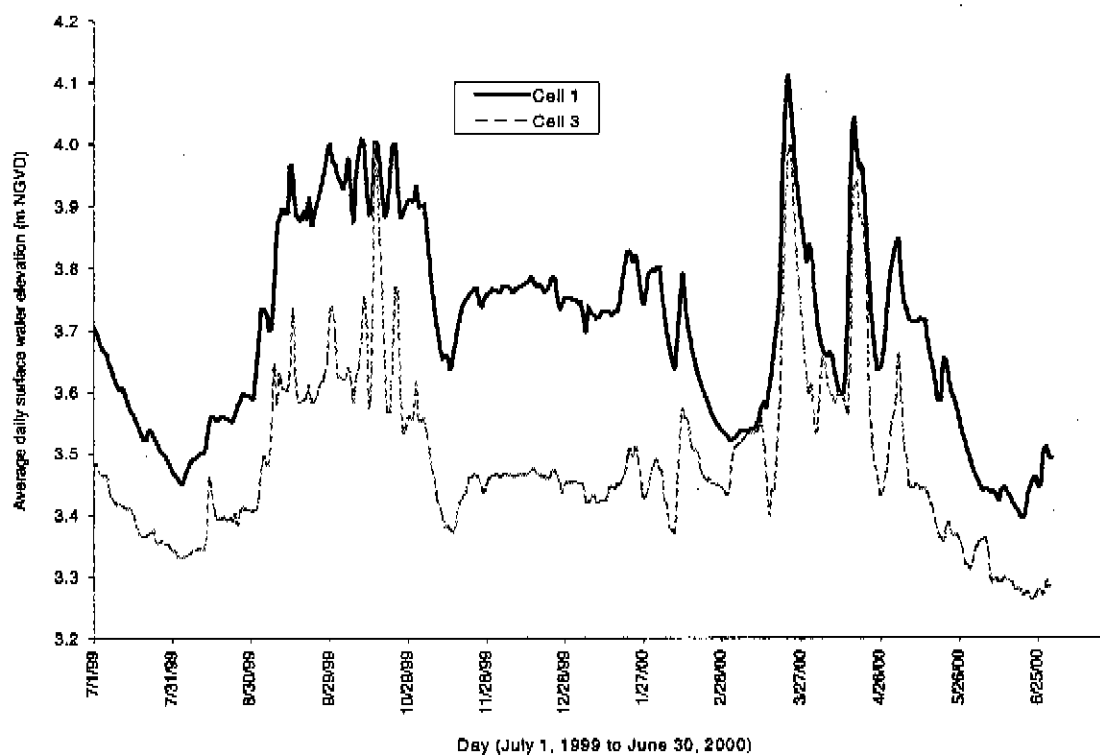


Figure 14. Daily mean water levels in Cells 1 and 3 of STA-1W

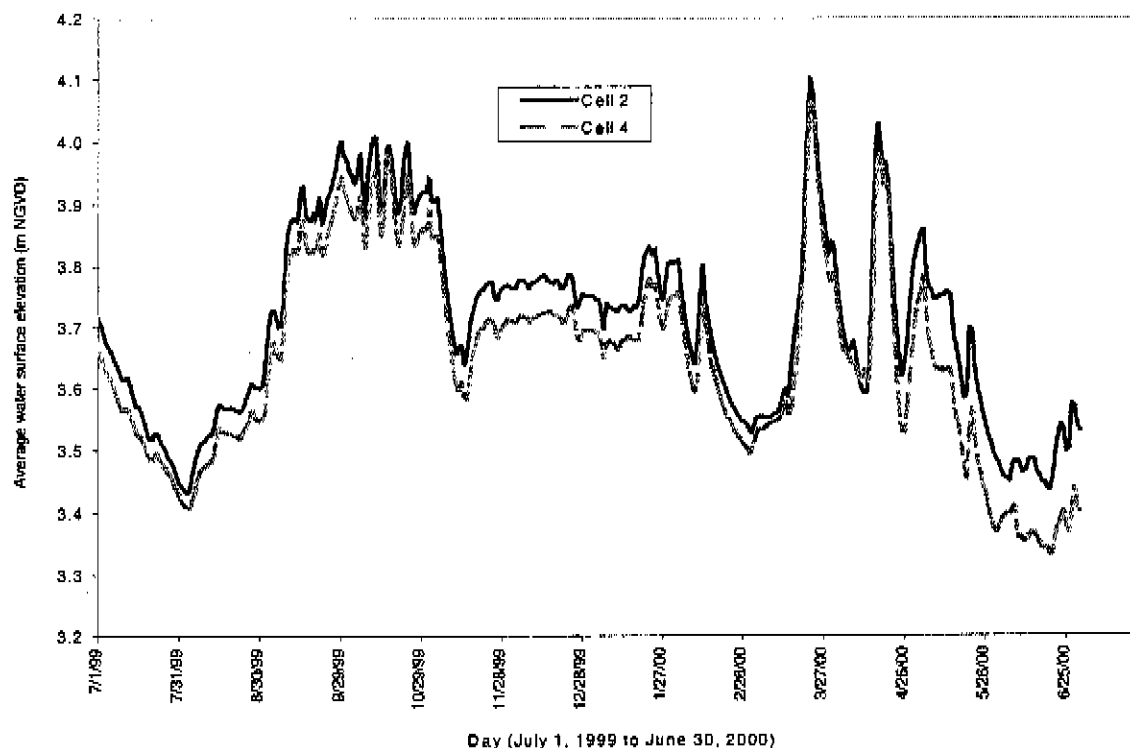


Figure 15. Daily mean water levels in Cells 2 and 4 of STA-1W

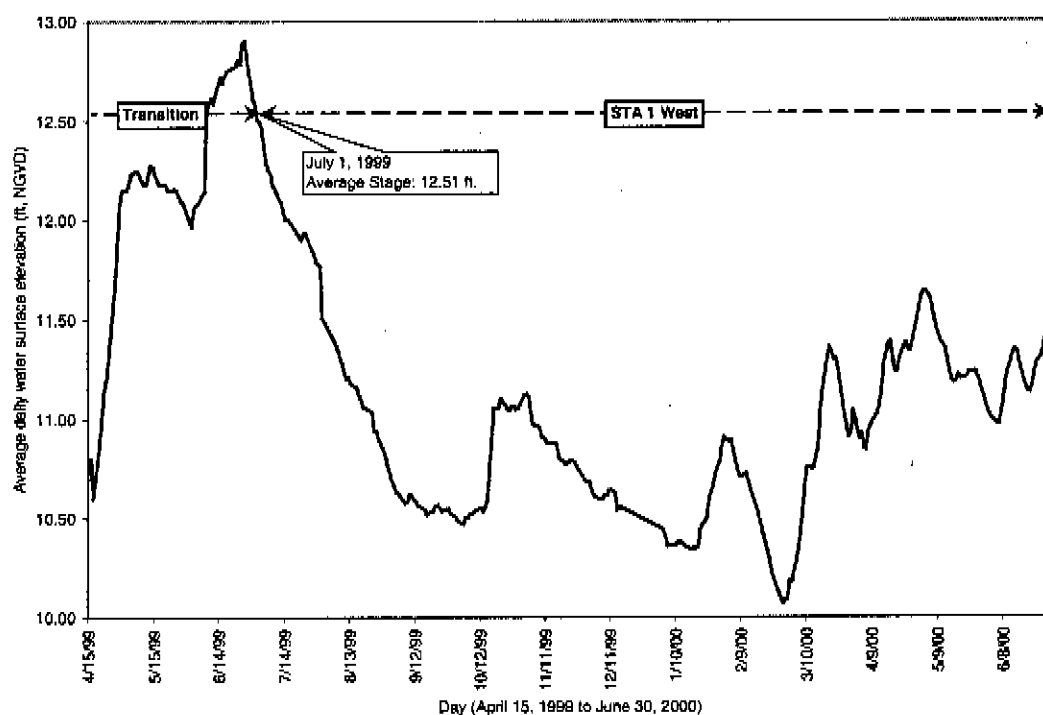


Figure 16. Daily mean water levels in Cell 5 of STA-1W

STA-1W WATER BUDGET COMPUTATIONS

STA-1W Water Balance Model

A schematic hydrologic model for STA-1W is depicted in **Figure 17**. The influent supplied through the G-302 spillway accounts for about 81.0% of the known inflow to the system. The known inflows to the system are G-302 spillway inflows, rainfall, and seepage through the roadside L-7 levee culverts (L-7a). Rainfall accounts for 15.5% and seepage through the roadside culverts (L-7a) accounts for 2.4%. Outflow pumping (G-251) accounts for 79.7% of the outflows, with evapotranspiration constituting 20.3% of the total outflows. The unknowns in the system are ungaged surface flows during construction, subsurface inflows, outflows and errors that account for 1.1%. The schematic model (**Figure 17**) and the following set of water balance equations represent the hydrologic system of STA-1W for water budget analysis purposes.

$$INFLOW - OUTFLOW = \Delta S + \epsilon_T \quad (8)$$

where INFLOW is the amount of water that enters the system from external sources, and OUTFLOW is water that leaves the system boundary and is not recirculated. ΔS is the change in storage in the system during the time interval of interest. Sum of all errors is represented by ϵ_T . Because all inflow and outflow can not be entirely quantified, the following equation is introduced to represent the remainders, errors and unknowns:

$$REMAINDERS = \epsilon_T + UNKNOWNNS \quad (9)$$

Figure 17 shows the possible inflows and outflows to and from STA-1W system. The seepage canal, which encompasses the northern side of STA-1W, is designed to capture seepage from STA-1W to the neighboring area. Seepage through the old ENR supply canal is represented as SEEP1 and seepage in and out of the seepage canal to the north is represented as SEEP2. SEEP3 represents the two seepage possibilities into or out of the discharge canal to the west, regardless of the magnitude. SEEP4 represents the possible seepage loss through the southern levee into the old Knight's Farm or into WCA1. The unmeasured seepage flow from WCA 1 into STA-1W from the east is represented by L-7b.

In computing the water balance for STA-1W, it is essential to identify quantifiable variables from unquantifiable variables, making reasonable assumptions to reduce the quantity of unknowns as much as possible. Since the purpose of the seepage canal is to recirculate seepage and recycled water, it is assumed that the seepage return pump flows are recirculation in the system. Change in storage is represented as follows.

$$\Delta S = G302 + R + L7a + L7b - G251 - G310 - ET - SEEP1 - SEEP2 - SEEP3 - SEEP4 + \epsilon_T \quad (10)$$

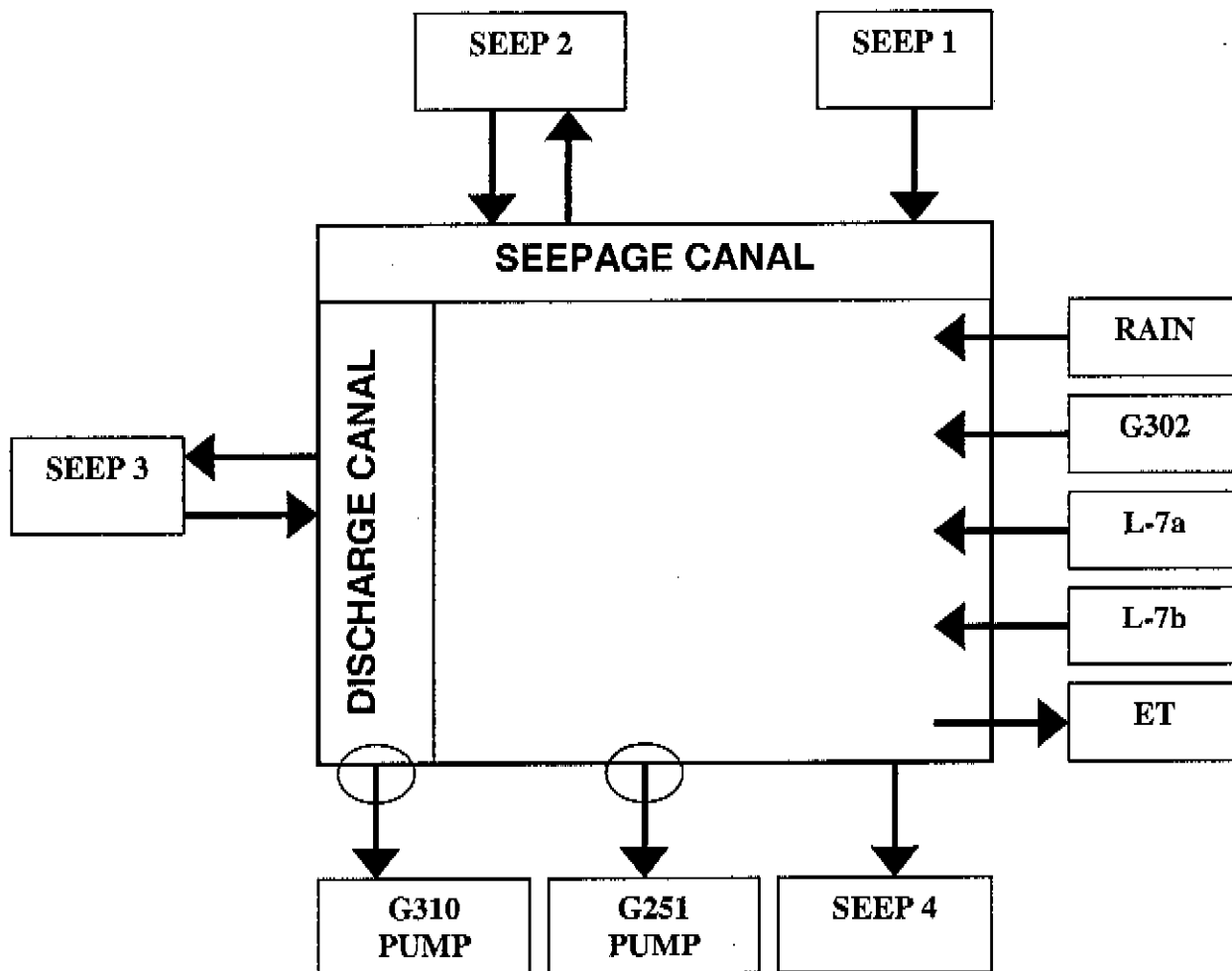


Figure 17. Schematic hydrologic model for STA-1W

where ΔS is change in storage in the system; G-302 is inflow; R is rainfall; L-7a is seepage flow from WCA 1 through the roadside culverts; L-7b is unknown subsurface seepage flow from WCA1 into STA-1W; ET is evapotranspiration losses; SEEP1 is seepage inflow from old ENR supply canal; SEEP2 is seepage to the north from or into the seepage canal; SEEP3 represents the two seepage possibilities into or out of the discharge canal to the west. SEEP4 represents the possible seepage loss or gain through the southern levee of STA-1W. G-310 and G-251 represent outflow pumping; ϵ_T represents total errors in inflow and outflow terms.

Daily change in storage for STA-1W was computed as sum of storage changes in each of the five cells (Cell 1, Cell 2, Cell 3, Cell 4 and Cell 5). Change in storage volume in each cell was computed from the area of the cell and change in stage. Change in stage was computed as the difference between the daily mean stage readings averaged from two or three locations in each cell (Table 12).

The remainders in the computation of daily water balances are the sum of all errors and unknowns in the system. Daily remainders were computed for the one-year study period based on the following equation:

$$\text{REMAINDERS} = \Delta S - \text{INFLOWS} + \text{OUTFLOWS} \quad (11)$$

Discussion

The total inflow through the inflow spillway was 14,636 ha-m (118,651 ac-ft) and was almost equivalent to total outflow through the outflow pump, which was 14,977 ha-m (121,416 ac-ft). Seepage inflow from the L-7 levee through the roadside culverts was a total of 438 ha-m (3,551 ac-ft). The seepage and recirculation pump had a total flow of 6,688 ha-m (54,218 ac-ft). Total average areal rainfall for the study period was 100.8 cm (39.7 inches) and the total average areal evapotranspiration was 137.6 cm (54.2 inches). Rainfall was drier than normal and ET was higher than the five-year ENR average.

For the study period, the mean daily remainders (errors and unknowns) was 0.61 ha-m per day or 4.95 ac-ft per day with the total remainders being 197 ha-m (1,597 ac-ft). The standard deviation of the remainders is 41 ha-m d⁻¹ (323 ac-ft d⁻¹) which signifies high variation. Figure 18 depicts the daily remainders distribution. The positive remainder indicates that there is an overall inflow to the system through unidentified directions. The remainder is 1.1% of the total inflows. Summary of the one-year water budget is shown in Table 14. Details of the water balance terms and calculation results are shown in Appendix III.

The mean hydraulic loading rate for the study period, based on the G-302 spillway inflow, was 1.45 centimeters per day (cm d⁻¹) or 0.57 inches per day (in d⁻¹). The mean hydraulic retention time was computed as the ratio of the mean-estimated water volume of the ENR and the average daily outflow rate. The mean-estimated volume was computed from the area-weighted (by cell) mean depth of 51.9 cm (20.4 inches) and total area of 2,772 ha (6,849 ac). The estimated mean hydraulic retention time was 35.2 days.

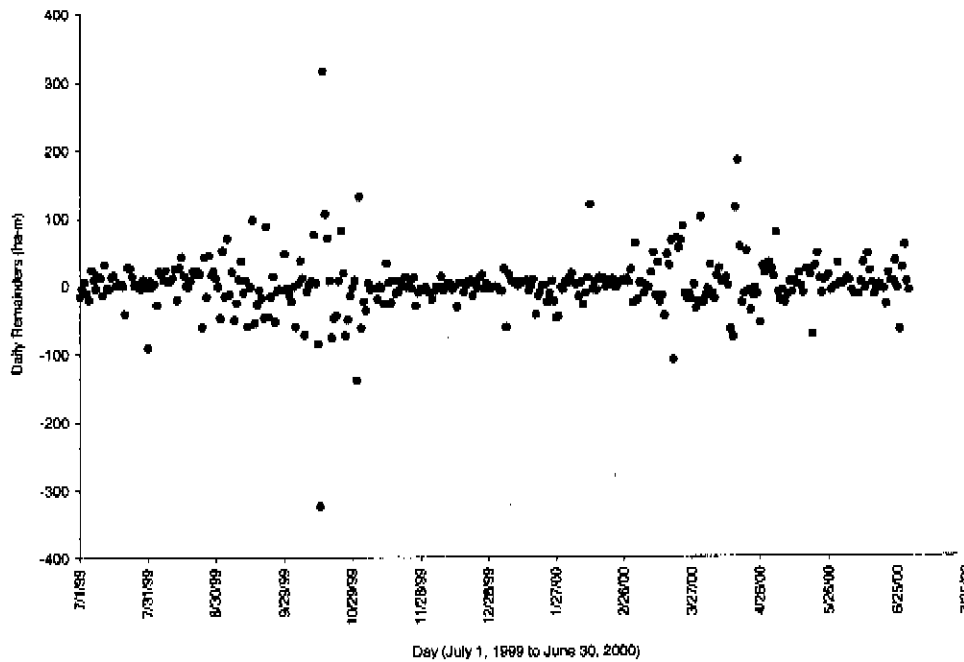


Figure 18. Distribution of daily remainders (errors and unknowns) from STA-1W water balance

STA-1W WATER BUDGET SUMMARY

STA-1W has been in operation for one year but the main outflow structure pump station G-310 has been under construction. G-310 pump testing started in July 2000. This water budget study covers the first year of operation of STA-1W (July 1, 1999 to June 30, 2000). For the period of analysis, the total inflow through the inflow spillway (G-302) was 14,636 ha-m or 118,651 ac-ft and the total outflow through the outflow pump (G-251) was 14,977 ha-m (121,416 ac-ft). Seepage inflow from the L-7 levee through the roadside culverts was a total of 438 ha-m (3,551 ac-ft). The seepage and recirculation pump had a total flow of 6,688 ha-m (54,218 ac-ft). Total areal average rainfall for the study period was 100.8 cm (39.7 inches) and the total areal average evapotranspiration was 137.6 cm (54.2 inches). The sum of the errors and unknowns, was 1.1% of the inflows to the system.

The mean hydraulic loading rate for the one-year period, based on the G-302 inflow, was 1.45 cm d⁻¹ (0.57 in d⁻¹). The mean hydraulic retention time was computed as the ratio of the mean-estimated volume of STA-1W and the average daily outflow rate. The mean-estimated volume was computed from the area-weighted (by cell) mean depth of 51.9 cm (20.4 inches) and total area of 2772 ha (6849 ac). The estimated mean hydraulic retention time was 35.2 days.

In STA-1W, all hydrologic parameters, with the exception of seepage through the system, are well monitored. Since the direction of seepage is not in one direction, the remainders (errors and unknowns) could not be allocated to one variable.

Table 14. Summary of water budget for STA-1W (July 1, 1999 to June 30, 2000).

INFLOWS	ha-m	Percent of Total	OUTFLOWS	ha-m	Percent of Total
Spillway Inflow	14,636	81.0%	Outflow Pump	14,977	79.7%
Rain	2,794	15.5%	ET	3,815	20.3%
L-7 Culverts (L-7a)	438	2.4%			
Remainders	197	1.1 %			
Total	18,065	100%	Total	18,792	100%
Change in Storage -727					
Seepage/recirculation					
Seepage pump (ha-m)	6,688				
Loading Rate (cm d ⁻¹)	1.45				
Average depth (cm)	51.9				
Retention time (days)	35.2				

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APPENDIX I

ENR Water Balance Terms With Calculated Remainders

ENR Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Pump G-250	Seepage Pump G-250_S	Outflow Pump G-251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
8/20/98	10.590	0.000	12.111	18.348	0.781	25.491	3.860	6.525
8/21/98	1.216	9.366	13.374	25.453	0.918	42.747	5.142	-21.220
8/22/98	39.727	24.824	16.310	23.892	1.028	1.569	7.241	43.439
8/23/98	6.588	43.241	14.543	22.392	1.009	0.000	8.415	-6.854
8/24/98	-8.045	20.714	12.170	21.169	0.909	0.000	8.909	0.411
8/25/98	-23.280	0.000	11.761	18.935	0.709	0.000	9.357	4.303
8/26/98	-28.958	0.000	8.803	19.106	0.609	0.000	7.782	-2.678
8/27/98	-21.842	0.000	11.962	15.612	0.488	1.961	4.941	-3.738
8/28/98	-20.680	0.000	9.006	16.540	0.383	0.000	7.782	3.258
8/29/98	-27.089	0.000	11.788	13.132	0.400	0.000	8.307	-6.050
8/30/98	-18.267	0.000	8.762	12.835	0.416	1.569	8.631	1.215
8/31/98	-15.385	0.000	10.714	11.098	0.424	0.000	9.110	4.399
9/1/98	-9.170	0.000	9.307	11.470	0.450	34.119	7.921	-24.349
9/2/98	11.473	0.000	10.851	14.237	0.528	18.432	7.720	14.469
9/3/98	-3.545	0.000	11.052	12.968	0.540	0.000	8.832	17.714
9/4/98	-18.349	0.000	10.276	11.453	0.495	0.000	7.643	0.252
9/5/98	-0.989	0.000	12.053	9.799	0.532	16.471	2.270	-5.924
9/6/98	-6.348	0.000	8.899	8.030	0.643	0.000	7.967	9.005
9/7/98	-10.624	0.000	10.288	10.215	0.653	4.706	2.548	-3.220
9/8/98	1.410	0.000	13.552	9.721	0.666	28.629	7.133	-11.031
9/9/98	15.465	28.397	12.603	10.516	0.668	0.000	6.454	3.371
9/10/98	69.651	79.618	15.769	12.503	0.654	64.709	3.366	-59.462
9/11/98	73.760	79.518	14.098	21.541	0.613	0.000	5.126	20.295
9/12/98	26.230	79.751	11.453	22.368	0.581	0.000	5.512	-26.222
9/13/98	21.948	74.681	11.495	24.046	0.550	0.000	7.180	-22.057
9/14/98	0.886	39.035	17.526	25.245	0.539	5.883	7.674	-11.652
9/15/98	0.137	0.683	16.278	26.809	0.557	36.472	2.517	-8.250
9/16/98	32.348	46.837	16.207	38.017	0.843	25.099	1.575	-0.839
9/17/98	30.503	47.637	14.866	43.104	1.091	63.533	2.826	-35.829
9/18/98	47.080	69.731	17.482	51.058	1.590	38.825	3.057	-8.952
9/19/98	4.243	3.790	17.357	51.975	2.267	3.137	4.478	51.502
9/20/98	-26.435	0.000	16.532	45.372	2.485	16.471	3.937	3.917
9/21/98	-27.877	0.000	16.545	42.707	2.848	21.178	6.732	-2.463
9/22/98	-24.079	0.000	16.562	36.735	3.287	0.000	6.747	16.116
9/23/98	-30.549	0.000	14.206	31.024	3.485	0.000	5.759	2.749
9/24/98	-29.879	0.000	14.945	28.064	3.486	9.804	5.867	-9.238
9/25/98	22.487	0.000	15.886	31.609	3.709	54.512	2.347	-1.779
9/26/98	2.301	0.000	16.503	29.091	3.934	0.000	4.431	31.890
9/27/98	-30.947	0.000	16.444	25.947	3.911	0.000	6.917	-1.994
9/28/98	-12.193	32.825	16.278	17.952	3.387	0.000	6.948	-23.506
9/29/98	24.139	35.088	14.590	8.299	2.884	0.000	6.686	1.152
9/30/98	9.357	49.862	16.143	12.997	2.460	0.000	6.686	-23.281
10/1/98	39.648	31.687	16.099	12.906	2.153	0.000	6.902	25.617
10/2/98	-0.163	0.000	16.222	15.287	1.946	0.000	7.056	20.235
10/3/98	-5.414	0.000	16.178	15.519	1.829	0.000	7.226	15.502
10/4/98	-13.710	0.000	12.950	15.539	1.855	3.137	5.558	2.395

ENR Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Pump G-250	Seepage Pump G-250_S	Outflow Pump G-251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
10/5/98	-18.876	0.000	13.408	12.510	1.900	0.000	6.284	-1.982
10/6/98	-6.812	7.734	13.577	9.858	1.945	1.569	4.864	-3.339
10/7/98	8.284	62.411	25.717	23.731	1.919	0.000	7.010	-25.305
10/8/98	12.140	26.591	16.185	10.829	1.859	0.000	6.438	0.958
10/9/98	16.479	17.844	16.153	10.741	1.786	0.000	6.037	13.627
10/10/98	-0.905	0.000	14.169	11.913	1.761	0.392	4.879	13.734
10/11/98	-3.662	0.000	15.446	13.753	1.747	30.982	6.191	-16.447
10/12/98	26.488	49.157	16.202	16.241	1.740	1.961	4.570	-5.558
10/13/98	23.779	56.898	16.114	15.241	1.731	3.922	4.663	-18.869
10/14/98	33.023	79.455	15.874	18.911	1.631	0.000	3.690	-25.463
10/15/98	32.788	79.655	15.989	23.833	1.577	1.569	6.608	-19.571
10/16/98	35.350	79.525	15.979	28.724	1.599	8.628	6.315	-19.364
10/17/98	23.108	79.266	15.847	30.887	1.521	0.000	6.701	-20.091
10/18/98	17.405	79.308	15.772	34.327	1.455	0.000	6.068	-22.962
10/19/98	20.112	76.795	14.688	38.249	1.461	15.295	3.150	-32.040
10/20/98	21.783	65.420	15.860	40.405	1.606	2.745	5.512	-2.071
10/21/98	9.602	43.380	15.693	43.733	1.693	13.726	4.478	-0.987
10/22/98	-7.933	47.740	15.855	43.613	1.798	0.784	4.030	-10.613
10/23/98	-9.772	78.214	15.789	40.953	1.818	0.000	5.775	-43.076
10/24/98	5.934	78.062	15.715	40.204	1.832	0.000	5.126	-28.630
10/25/98	8.750	78.006	14.105	39.737	1.796	0.000	6.037	-25.278
10/26/98	5.171	75.410	15.789	43.366	1.784	0.000	6.068	-22.589
10/27/98	6.094	67.644	15.720	41.078	1.790	0.392	5.775	-16.879
10/28/98	1.581	40.669	15.718	42.575	1.775	0.000	6.083	7.795
10/29/98	-3.297	45.714	15.659	41.516	1.770	0.000	5.605	-3.660
10/30/98	0.965	51.892	13.777	41.924	1.732	0.000	5.620	-5.115
10/31/98	6.811	52.362	12.038	41.080	1.639	0.000	5.991	-0.119
11/1/98	5.127	52.409	14.029	43.035	1.578	0.000	6.330	0.506
11/2/98	7.203	52.342	13.271	43.911	1.567	0.000	4.385	1.590
11/3/98	4.978	52.308	11.052	43.823	1.563	0.000	3.057	-2.012
11/4/98	40.515	28.313	15.679	55.465	1.817	172.165	0.463	-105.853
11/5/98	263.534	31.577	31.609	88.297	3.153	118.829	1.081	199.352
11/6/98	-14.931	51.256	31.249	94.113	3.791	0.000	3.366	27.501
11/7/98	-37.771	51.484	25.500	90.015	4.331	0.000	4.632	1.061
11/8/98	-54.781	44.645	20.927	83.545	4.724	0.000	5.543	-15.061
11/9/98	-65.543	1.967	19.031	71.537	5.018	0.000	6.114	5.123
11/10/98	-65.156	0.000	18.686	59.458	5.211	0.000	5.697	-5.211
11/11/98	-51.211	0.000	16.843	52.242	5.381	0.000	6.500	2.149
11/12/98	-39.946	0.000	16.136	46.030	5.337	0.000	6.747	7.494
11/13/98	-37.009	0.000	15.987	40.559	5.131	0.000	6.979	5.398
11/14/98	-32.085	18.781	13.988	35.406	4.749	0.000	4.431	-15.777
11/15/98	5.389	41.352	14.264	32.297	4.274	0.000	6.022	-1.919
11/16/98	13.465	51.638	13.863	33.410	3.823	0.392	3.706	-5.273
11/17/98	18.607	51.858	13.562	35.673	3.452	0.000	3.860	2.830
11/18/98	10.241	30.202	11.881	37.978	3.131	0.000	4.092	18.977
11/19/98	-21.900	0.000	12.167	38.905	2.934	0.784	2.918	16.205

ENR Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Pump G-250	Seepage Pump G-250_S	Outflow Pump G-251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
11/20/98	-30.018	0.000	12.701	34.778	2.979	0.000	4.447	6.228
11/21/98	-21.456	15.987	14.651	38.475	2.956	0.000	5.512	3.587
11/22/98	-16.961	26.995	13.643	28.262	2.908	0.784	4.709	-14.677
11/23/98	13.816	50.735	10.920	27.386	2.814	0.784	4.323	-8.808
11/24/98	22.822	34.477	15.263	31.519	2.827	25.884	2.270	-6.576
11/25/98	27.325	18.960	14.538	34.961	2.908	0.000	5.620	46.039
11/26/98	-23.643	0.000	14.294	33.723	2.920	2.745	5.311	9.726
11/27/98	-26.898	0.000	14.602	30.533	2.920	0.000	5.589	6.304
11/28/98	-29.627	0.000	12.992	27.283	2.931	0.000	5.450	0.176
11/29/98	-25.067	0.000	12.400	24.673	2.941	0.000	4.261	0.927
11/30/98	-21.078	0.000	12.180	21.176	2.958	0.000	4.323	1.463
12/1/98	-7.951	31.790	12.488	19.505	2.909	11.765	3.937	-30.973
12/2/98	27.646	53.113	12.525	20.254	2.768	0.784	4.555	-4.210
12/3/98	23.723	29.676	13.144	22.754	2.676	0.000	4.076	18.202
12/4/98	10.694	44.021	13.210	24.817	2.628	5.883	4.570	-12.451
12/5/98	27.696	21.871	12.327	28.394	2.626	17.256	0.911	15.248
12/6/98	2.736	29.850	12.158	31.472	2.759	0.000	4.416	6.015
12/7/98	16.203	52.560	12.045	29.794	2.680	0.000	4.956	-4.288
12/8/98	12.456	23.921	11.996	32.314	2.590	0.784	2.764	20.238
12/9/98	-25.227	0.000	12.016	32.556	2.609	0.000	4.076	8.797
12/10/98	-27.470	0.000	11.712	29.931	2.621	0.000	4.508	4.348
12/11/98	-28.495	24.736	10.247	26.554	2.610	7.059	1.729	-34.617
12/12/98	20.464	53.096	10.888	26.650	2.602	0.784	1.096	-8.272
12/13/98	25.737	52.431	13.496	26.889	2.598	0.000	3.366	0.964
12/14/98	26.415	52.218	12.123	29.808	2.423	2.353	2.826	2.055
12/15/98	13.466	17.298	12.875	34.491	2.315	0.000	3.613	31.956
12/16/98	-29.727	0.000	13.954	32.487	2.293	0.000	4.508	4.975
12/17/98	-33.736	0.000	12.030	29.138	2.294	0.000	4.740	-2.151
12/18/98	-27.866	0.000	12.713	24.303	2.296	0.000	4.508	-1.351
12/19/98	-23.765	0.000	10.418	21.277	2.322	0.000	3.212	-1.599
12/20/98	-20.845	0.000	8.314	20.401	2.298	0.000	4.725	1.982
12/21/98	-15.392	0.000	14.379	18.840	2.260	0.000	4.478	5.664
12/22/98	-8.668	0.000	15.326	15.896	2.238	0.000	4.231	9.221
12/23/98	-9.728	0.000	14.044	15.368	2.211	0.000	3.783	7.212
12/24/98	-18.570	0.000	15.062	14.455	2.180	0.000	4.092	-2.203
12/25/98	-10.623	0.000	13.418	12.461	2.129	0.000	4.246	3.955
12/26/98	-8.662	0.000	11.756	13.440	2.055	2.745	3.289	3.266
12/27/98	-10.188	0.000	12.630	12.297	2.006	0.000	4.277	4.380
12/28/98	7.871	0.000	13.298	13.728	1.998	44.316	2.054	-22.661
12/29/98	33.393	17.790	16.256	16.107	2.026	0.392	4.817	34.109
12/30/98	2.305	26.586	14.105	15.074	1.957	0.000	5.064	-6.099
12/31/98	16.279	26.584	14.365	15.299	1.875	0.000	4.817	7.938
1/1/99	16.329	26.581	13.215	18.262	1.784	0.000	4.045	10.272
1/2/99	17.984	26.576	13.978	21.406	1.871	18.040	2.887	-4.210
1/3/99	25.816	22.272	13.604	27.866	2.142	12.550	2.887	19.604
1/4/99	2.536	24.230	14.198	26.109	2.138	2.353	1.158	1.082

ENR Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Pump G-250	Seepage Pump G-250_S	Outflow Pump G-251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
1/5/99	-0.704	18.482	14.783	26.256	2.053	0.784	3.459	7.691
1/6/99	-12.958	16.031	14.054	25.336	2.010	0.000	4.601	-1.062
1/7/99	-0.482	26.429	12.899	24.274	2.059	0.000	4.030	-0.667
1/8/99	3.863	24.563	14.675	22.649	2.116	0.000	3.165	2.999
1/9/99	0.935	26.574	11.583	22.896	2.016	0.000	4.323	-0.435
1/10/99	8.145	26.571	13.936	24.761	1.890	3.137	1.158	2.465
1/11/99	2.807	26.557	13.851	26.336	1.883	0.000	4.323	5.027
1/12/99	-2.521	26.574	12.407	25.916	1.923	0.000	3.459	-1.643
1/13/99	1.167	26.574	13.300	25.588	1.919	3.922	3.165	-2.494
1/14/99	5.704	26.571	13.491	25.783	1.910	0.392	3.165	5.779
1/15/99	0.622	23.970	9.794	26.106	1.950	0.000	3.165	3.974
1/16/99	0.609	26.552	14.044	26.207	1.852	0.000	4.323	2.735
1/17/99	-0.361	26.571	11.451	25.534	1.795	0.000	4.045	0.852
1/18/99	-2.081	26.574	11.162	26.116	1.713	0.000	3.752	-0.500
1/19/99	1.306	26.588	12.970	25.896	1.693	0.000	4.339	3.259
1/20/99	2.011	26.569	12.197	26.410	1.669	0.000	4.045	4.228
1/21/99	-2.149	26.569	13.521	25.575	1.649	0.000	4.617	-0.175
1/22/99	-0.642	22.272	11.730	25.573	1.669	0.000	4.617	5.606
1/23/99	-5.366	26.571	11.830	23.929	1.640	0.000	4.632	-5.016
1/24/99	35.694	26.559	13.895	29.013	1.566	38.825	2.887	0.644
1/25/99	11.275	22.468	13.229	31.648	1.604	0.000	4.617	23.467
1/26/99	-10.405	31.107	13.063	31.949	1.557	0.392	5.203	-6.309
1/27/99	-5.132	35.382	13.924	30.709	1.512	0.000	4.910	-6.408
1/28/99	5.358	31.986	13.210	27.242	1.472	0.000	4.910	4.052
1/29/99	-1.254	37.975	15.940	31.166	1.447	0.000	4.045	-5.465
1/30/99	2.106	43.255	13.958	29.456	1.355	0.000	5.203	-7.845
1/31/99	7.725	41.364	10.085	30.706	1.241	7.451	1.729	-9.896
2/1/99	26.285	61.023	13.396	48.127	1.388	11.373	2.023	2.650
2/2/99	11.248	44.178	15.798	34.159	1.414	0.000	3.474	3.289
2/3/99	7.355	33.892	15.838	35.494	1.372	0.000	4.925	12.512
2/4/99	-7.535	26.549	11.764	35.827	1.295	0.000	5.512	5.960
2/5/99	-14.451	26.557	8.140	35.568	1.257	0.000	4.925	-1.771
2/6/99	-17.132	26.564	5.931	35.208	1.197	0.000	4.925	-4.760
2/7/99	-10.133	26.564	6.711	32.735	1.152	0.000	3.474	-1.640
2/8/99	-10.707	26.566	9.980	31.585	1.149	0.000	3.474	-3.364
2/9/99	-13.655	26.566	11.781	30.540	1.144	0.000	3.474	-7.351
2/10/99	-5.567	25.739	8.620	29.659	1.269	0.000	3.181	0.264
2/11/99	-9.180	25.761	5.669	29.326	1.286	0.392	4.339	-2.954
2/12/99	6.501	25.458	6.755	23.339	1.278	5.098	3.474	1.481
2/13/99	34.213	0.000	6.518	10.467	1.252	0.000	2.903	46.331
2/14/99	-18.084	0.000	7.144	17.195	1.195	0.000	4.632	2.549
2/15/99	-22.499	0.000	4.913	17.164	1.199	0.000	3.181	-3.354
2/16/99	-31.677	16.706	4.583	27.775	1.260	0.000	2.887	-18.982
2/17/99	-39.968	21.441	4.881	24.081	1.261	0.000	3.752	-34.837
2/18/99	1.328	26.586	4.734	19.784	1.287	5.490	4.910	-7.341
2/19/99	5.812	26.510	4.727	18.549	1.308	0.000	4.632	1.174

ENR Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Pump G-250	Seepage Pump G-250_S	Outflow Pump G-251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
2/20/99	1.478	26.584	6.665	19.427	1.161	0.000	5.497	-1.342
2/21/99	2.857	26.584	6.944	20.875	1.050	0.000	4.910	1.009
2/22/99	-3.649	26.586	3.966	21.783	1.013	0.000	5.775	-3.691
2/23/99	-4.379	22.608	3.614	21.250	1.023	0.000	3.181	-3.579
2/24/99	-16.529	0.000	5.109	20.545	0.949	0.000	5.775	8.842
2/25/99	-21.659	0.000	3.068	17.998	0.955	0.000	5.188	0.572
2/26/99	-21.720	0.000	0.793	16.503	0.938	0.000	5.775	-0.380
2/27/99	-30.381	0.000	0.000	14.237	0.941	0.000	5.775	-11.310
2/28/99	-18.187	0.000	0.000	11.725	0.936	0.000	5.188	-2.211
3/1/99	-17.000	0.000	0.000	9.733	0.889	0.000	6.052	-2.103
3/2/99	-16.328	0.000	0.000	9.165	0.890	0.000	6.037	-2.015
3/3/99	-6.847	0.000	0.000	8.192	0.890	8.236	2.007	-5.775
3/4/99	8.938	0.000	0.000	1.603	0.820	0.000	6.902	16.622
3/5/99	2.827	0.000	0.000	0.000	0.801	0.000	6.624	8.649
3/6/99	-3.788	0.000	0.000	0.000	0.775	0.000	5.188	0.624
3/7/99	-4.997	0.000	0.000	0.000	0.709	0.000	6.052	0.346
3/8/99	-31.448	1.258	0.000	16.229	0.666	0.000	5.759	-11.384
3/9/99	-30.306	0.000	0.000	6.567	0.656	0.000	6.330	-18.065
3/10/99	-12.216	0.000	0.000	5.723	0.548	0.000	5.188	-1.854
3/11/99	-10.326	0.000	0.000	4.194	0.502	0.000	6.624	-0.010
3/12/99	-10.445	0.000	0.000	10.306	0.497	0.000	6.330	5.694
3/13/99	-13.056	0.000	0.000	3.545	0.514	0.000	4.894	-5.130
3/14/99	-9.788	0.000	0.000	3.044	0.540	1.961	4.617	-4.628
3/15/99	-5.454	0.000	0.000	3.513	0.409	0.000	3.459	1.108
3/16/99	-5.094	0.000	0.000	2.439	0.378	0.392	6.624	3.199
3/17/99	-9.244	0.000	0.000	2.924	0.378	0.000	6.330	-0.367
3/18/99	-6.263	0.000	0.000	2.408	0.338	0.000	5.759	1.566
3/19/99	-7.760	0.000	0.000	3.098	0.277	0.000	7.195	2.255
3/20/99	-7.800	0.000	0.000	2.200	0.229	0.000	4.894	-0.934
3/21/99	-7.565	0.000	0.000	2.107	0.165	0.000	6.052	0.430
3/22/99	-9.095	0.000	0.000	2.425	0.088	0.000	7.488	0.730
3/23/99	-1.626	6.792	0.000	1.588	0.071	0.000	5.759	-1.142
3/24/99	8.437	20.814	0.000	2.148	0.035	0.000	6.639	-3.624
3/25/99	24.248	35.438	0.000	1.006	0.010	0.000	6.655	-3.541
3/26/99	22.805	35.827	0.000	2.400	0.000	14.903	5.203	-20.321
3/27/99	31.643	35.255	0.000	2.846	0.000	0.000	7.519	6.753
3/28/99	22.143	35.299	0.000	4.470	0.000	0.000	6.068	-2.617
3/29/99	18.666	35.338	0.000	5.718	0.000	0.000	4.910	-6.044
3/30/99	17.842	35.216	0.000	13.457	0.000	0.000	5.775	1.858
3/31/99	15.266	35.098	0.000	7.568	0.000	0.000	4.339	-7.926
4/1/99	16.943	35.098	0.000	9.665	0.000	0.784	6.068	-3.207
4/2/99	16.627	35.093	0.000	10.717	0.000	0.000	6.655	-1.095
4/3/99	15.479	35.191	0.000	12.089	0.000	0.000	7.519	-0.104
4/4/99	9.444	34.193	0.000	14.235	0.000	0.000	6.933	-3.581
4/5/99	12.386	43.449	0.000	14.399	0.000	0.000	7.210	-9.453
4/6/99	20.844	49.847	0.000	15.730	0.000	0.000	5.775	-7.499

ENR Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Pump G-250	Seepage Pump G-250_S	Outflow Pump G-251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
4/7/99	16.028	49.634	0.000	17.646	0.000	0.000	7.519	-8.441
4/8/99	25.203	46.128	0.000	18.018	0.000	0.000	7.226	4.319
4/9/99	13.049	46.390	0.000	21.355	0.000	0.000	7.226	-4.760
4/10/99	11.276	49.460	0.000	24.893	0.000	0.000	7.813	-5.479
4/11/99	14.067	49.940	0.000	26.554	0.000	0.000	7.241	-2.078
4/12/99	12.845	49.539	0.000	29.089	0.000	0.000	5.790	-1.814
4/13/99	5.460	42.526	0.000	29.551	0.000	0.000	7.813	0.298
4/14/99	1.409	38.477	0.000	28.406	0.000	0.000	7.241	-1.421
4/15/99	-3.095	34.056	0.000	20.012	0.000	0.000	7.241	-9.898
4/16/99	37.004	36.794	0.000	13.946	0.000	0.000	6.377	20.533
4/17/99	11.893	41.264	0.000	19.730	0.000	0.392	3.181	-6.852
4/18/99	12.099	42.142	0.000	19.645	0.000	0.392	4.925	-5.865
4/19/99	3.430	46.700	0.000	27.029	0.000	0.000	7.226	-9.016
4/20/99	5.476	38.912	0.000	23.474	0.000	0.000	8.106	-1.857
4/21/99	-6.197	34.648	0.000	34.533	0.000	0.000	8.399	2.087
4/22/99	-31.574	38.364	0.000	37.789	0.000	0.000	6.670	-25.479
4/23/99	-13.537	40.933	0.000	32.438	0.000	0.000	6.686	-15.346
4/24/99	2.566	42.575	0.000	30.454	0.000	0.000	7.859	-1.696
4/25/99	0.450	41.455	0.000	29.953	0.000	0.000	6.408	-4.644
4/26/99	-0.780	38.697	0.000	44.173	0.000	0.000	7.272	11.968
4/27/99	15.120	37.317	0.000	30.630	0.000	36.080	4.076	-23.571
4/28/99	25.712	41.183	0.000	35.605	0.000	7.059	3.196	16.270
4/29/99	2.718	42.517	0.000	36.221	0.000	0.392	6.114	2.144
4/30/99	5.083	49.294	0.000	34.073	0.000	0.392	7.288	-3.243
5/1/99	2.115	49.428	0.000	36.821	0.000	0.000	6.979	-3.514
5/2/99	0.593	49.394	0.000	36.950	0.000	0.000	9.017	-2.834
5/3/99	1.266	42.245	0.000	36.463	0.000	0.000	6.979	2.464
5/4/99	-3.653	39.353	0.000	35.940	0.000	0.000	8.152	1.087
5/5/99	-7.310	38.245	0.000	32.646	0.000	0.000	6.114	-6.794
5/6/99	-5.658	37.041	0.000	30.674	0.000	0.000	8.446	-3.579
5/7/99	-5.587	33.933	0.000	29.204	0.000	0.000	8.461	-1.855
5/8/99	-4.923	44.863	0.000	30.643	0.000	0.000	6.130	-13.013
5/9/99	-1.043	22.172	0.000	31.514	0.000	7.059	6.099	7.338
5/10/99	-15.957	18.270	0.000	30.922	0.000	0.392	8.415	4.718
5/11/99	13.735	35.908	0.000	28.252	0.000	44.316	5.234	-33.002
5/12/99	10.913	6.215	0.000	32.394	0.000	9.020	3.489	31.563
5/13/99	-29.551	0.024	0.000	27.878	0.000	0.000	8.415	6.717
5/14/99	-34.001	0.000	0.000	23.307	0.000	0.000	7.550	-3.143
5/15/99	-19.086	0.000	0.000	21.286	0.000	21.178	2.903	-16.074
5/16/99	-13.923	0.000	0.000	20.183	0.000	0.000	6.099	12.358
5/17/99	-29.344	0.037	0.000	17.514	0.000	0.000	6.963	-4.903
5/18/99	-28.911	0.000	0.000	14.680	0.000	1.961	6.670	-9.521
5/19/99	-19.985	0.000	0.000	11.265	0.000	0.784	7.257	-2.248
5/20/99	-18.684	0.000	0.000	10.783	0.000	0.000	4.354	-3.548
5/21/99	-15.843	0.000	0.000	9.192	0.000	0.392	6.670	-0.373
5/22/99	-6.970	0.000	0.000	7.135	0.000	18.432	6.670	-11.598

ENR Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Pump G-250	Seepage Pump G-250_S	Outflow Pump G-251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
5/23/99	-6.644	0.000	0.000	8.683	0.000	0.000	8.986	11.025
5/24/99	-14.023	0.000	0.000	7.418	0.000	0.000	6.670	0.065
5/25/99	-14.939	0.000	0.000	6.401	0.000	0.000	7.828	-0.710
5/26/99	1.549	25.448	0.000	5.439	0.000	0.000	8.121	-10.338
5/27/99	22.608	41.477	0.000	5.591	0.000	0.000	8.708	-4.570
5/28/99	15.585	38.357	0.000	6.190	0.000	0.000	8.121	-8.460
5/29/99	19.910	47.943	0.000	8.094	0.000	0.784	5.219	-15.506
5/30/99	24.103	44.290	0.000	11.470	0.000	0.000	4.647	-4.070
5/31/99	22.478	43.860	0.000	14.661	0.000	0.000	6.670	-0.051
6/1/99	27.839	42.392	0.000	19.053	0.000	25.884	3.767	-17.617
6/2/99	27.064	11.984	0.000	20.440	0.000	8.236	3.721	31.005
6/3/99	-16.678	0.122	0.000	21.551	0.000	0.392	5.512	9.870
6/4/99	-25.903	0.000	0.000	18.585	0.000	0.000	7.519	0.201
6/5/99	-31.060	0.000	0.000	14.697	0.000	0.000	7.241	-9.121
6/6/99	-19.181	0.000	0.000	11.984	0.000	0.392	8.106	0.517
6/7/99	55.357	19.057	0.000	21.081	0.000	167.851	1.158	-109.313
6/8/99	142.468	38.440	0.000	37.924	0.496	51.375	2.023	92.102
6/9/99	20.996	47.750	0.000	36.441	0.960	0.000	6.361	15.088
6/10/99	-4.056	23.302	0.000	35.450	1.307	7.844	5.790	4.732
6/11/99	5.816	17.171	0.000	37.770	1.514	38.433	5.790	-7.742
6/12/99	26.710	17.073	0.000	39.739	1.567	23.138	4.061	28.732
6/13/99	-6.612	17.178	0.000	37.914	1.540	0.000	7.535	20.119
6/14/99	-25.037	21.636	0.000	35.455	1.384	3.137	7.257	-8.483
6/15/99	-4.080	37.520	0.000	32.783	1.211	0.000	5.188	-4.841
6/16/99	-9.175	31.196	0.000	34.056	1.162	13.334	3.736	-17.075
6/17/99	2.764	17.230	0.000	33.116	1.282	10.589	5.342	12.121
6/18/99	-0.337	0.000	0.000	33.483	1.690	23.138	2.964	11.283
6/19/99	-14.684	0.000	0.000	34.039	1.964	7.059	3.165	13.496
6/20/99	-28.724	0.000	0.000	30.731	1.922	0.000	5.389	5.473
6/21/99	-36.123	0.000	0.000	25.938	1.814	1.177	8.893	-4.282
6/22/99	-25.235	0.000	0.000	21.719	1.817	1.961	7.164	-0.129
6/23/99	5.279	11.277	0.000	25.688	1.756	50.983	6.408	-26.642
6/24/99	35.890	29.424	0.000	27.149	1.910	10.589	6.207	27.323
6/25/99	7.967	21.032	0.000	24.631	1.981	9.020	5.126	5.691
6/26/99	30.473	26.385	0.000	27.048	1.894	2.353	5.713	32.602
6/27/99	27.757	17.012	0.000	28.548	2.001	10.589	6.006	32.709
6/28/99	25.207	25.098	0.000	31.996	1.831	0.000	5.111	35.384
6/29/99	21.767	31.252	0.000	33.794	1.706	7.451	5.219	20.371
6/30/99	14.871	32.901	0.000	37.146	1.673	0.784	4.431	21.090

APPENDIX II
STA-1W Cell 5 Average Stage

STA 1 West, Cell 5 Average Stage

(Cell 5 average stage is computed from manual readings available at G-304, Tailwater, G-305, Head and Tailwater, and G-306, Headwater. Sources of manual readings are from OMD archive data and hardcopies from construction site)

Date	Stage (ft)	Date	Stage (ft)	Date	Stage (ft)	Date	Stage (ft)
04/15/99	10.74	05/21/99	12.15	06/26/99	12.83	08/01/99	11.49
04/16/99	10.80	05/22/99	12.15	06/27/99	12.75	08/02/99	11.47
04/17/99	10.60	05/23/99	12.15	06/28/99	12.69	08/03/99	11.45
04/18/99	10.69	05/24/99	12.15	06/29/99	12.61	08/04/99	11.42
04/19/99	10.78	05/25/99	12.15	06/30/99	12.58	08/05/99	11.40
04/20/99	10.88	05/26/99	12.12	07/01/99	12.51	08/06/99	11.38
04/21/99	11.00	05/27/99	12.10	07/02/99	12.50	08/07/99	11.35
04/22/99	11.15	05/28/99	12.08	07/03/99	12.46	08/08/99	11.32
04/23/99	11.21	05/29/99	12.06	07/04/99	12.38	08/09/99	11.29
04/24/99	11.30	05/30/99	12.03	07/05/99	12.29	08/10/99	11.24
04/25/99	11.43	05/31/99	12.00	07/06/99	12.25	08/11/99	11.21
04/26/99	11.57	06/01/99	11.97	07/07/99	12.23	08/12/99	11.21
04/27/99	11.70	06/02/99	12.05	07/08/99	12.17	08/13/99	11.18
04/28/99	11.91	06/03/99	12.07	07/09/99	12.16	08/14/99	11.17
04/29/99	12.08	06/04/99	12.08	07/10/99	12.13	08/15/99	11.17
04/30/99	12.14	06/05/99	12.10	07/11/99	12.11	08/16/99	11.16
05/01/99	12.15	06/06/99	12.12	07/12/99	12.09	08/17/99	11.12
05/02/99	12.15	06/07/99	12.14	07/13/99	12.03	08/18/99	11.09
05/03/99	12.17	06/08/99	12.52	07/14/99	12.00	08/19/99	11.06
05/04/99	12.22	06/09/99	12.59	07/15/99	12.00	08/20/99	11.06
05/05/99	12.24	06/10/99	12.61	07/16/99	11.99	08/21/99	11.05
05/06/99	12.25	06/11/99	12.59	07/17/99	11.97	08/22/99	11.04
05/07/99	12.24	06/12/99	12.63	07/18/99	11.95	08/23/99	11.03
05/08/99	12.22	06/13/99	12.68	07/19/99	11.94	08/24/99	10.94
05/09/99	12.20	06/14/99	12.72	07/20/99	11.92	08/25/99	10.94
05/10/99	12.18	06/15/99	12.69	07/21/99	11.90	08/26/99	10.90
05/11/99	12.18	06/16/99	12.72	07/22/99	11.93	08/27/99	10.87
05/12/99	12.23	06/17/99	12.75	07/23/99	11.93	08/28/99	10.85
05/13/99	12.27	06/18/99	12.76	07/24/99	11.91	08/29/99	10.82
05/14/99	12.27	06/19/99	12.76	07/25/99	11.88	08/30/99	10.77
05/15/99	12.23	06/20/99	12.77	07/26/99	11.85	08/31/99	10.73
05/16/99	12.20	06/21/99	12.78	07/27/99	11.83	09/01/99	10.69
05/17/99	12.18	06/22/99	12.81	07/28/99	11.79	09/02/99	10.66
05/18/99	12.18	06/23/99	12.79	07/29/99	11.78	09/03/99	10.64
05/19/99	12.18	06/24/99	12.89	07/30/99	11.77	09/04/99	10.62
05/20/99	12.18	06/25/99	12.90	07/31/99	11.51	09/05/99	10.61

Date	Stage (ft)	Date	Stage (ft)	Date	Stage (ft)	Date	Stage (ft)
09/06/99	10.59	10/19/99	11.05	12/01/99	10.68	01/13/00	10.37
09/07/99	10.58	10/20/99	11.06	12/02/99	10.64	01/14/00	10.36
09/08/99	10.58	10/21/99	11.11	12/03/99	10.61	01/15/00	10.35
09/09/99	10.61	10/22/99	11.09	12/04/99	10.60	01/16/00	10.34
09/10/99	10.62	10/23/99	11.07	12/05/99	10.60	01/17/00	10.34
09/11/99	10.60	10/24/99	11.05	12/06/99	10.59	01/18/00	10.35
09/12/99	10.58	10/25/99	11.04	12/07/99	10.59	01/19/00	10.34
09/13/99	10.56	10/26/99	11.06	12/08/99	10.61	01/20/00	10.35
09/14/99	10.56	10/27/99	11.07	12/09/99	10.61	01/21/00	10.43
09/15/99	10.55	10/28/99	11.05	12/10/99	10.64	01/22/00	10.46
09/16/99	10.54	10/29/99	11.05	12/11/99	10.64	01/23/00	10.47
09/17/99	10.52	10/30/99	11.07	12/12/99	10.64	01/24/00	10.50
09/18/99	10.53	10/31/99	11.10	12/13/99	10.62	01/25/00	10.59
09/19/99	10.53	11/01/99	11.12	12/14/99	10.54	01/26/00	10.63
09/20/99	10.54	11/02/99	11.13	12/15/99	10.55	01/27/00	10.66
09/21/99	10.56	11/03/99	11.11	12/16/99	10.55	01/28/00	10.72
09/22/99	10.57	11/04/99	11.02	12/17/99	10.55	01/29/00	10.76
09/23/99	10.55	11/05/99	10.97	12/18/99	10.54	01/30/00	10.78
09/24/99	10.53	11/06/99	10.97	12/19/99	10.53	01/31/00	10.86
09/25/99	10.54	11/07/99	10.97	12/20/99	10.53	02/01/00	10.91
09/26/99	10.55	11/08/99	10.95	12/21/99	10.52	02/02/00	10.90
09/27/99	10.55	11/09/99	10.91	12/22/99	10.52	02/03/00	10.89
09/28/99	10.52	11/10/99	10.90	12/23/99	10.51	02/04/00	10.89
09/29/99	10.52	11/11/99	10.89	12/24/99	10.50	02/05/00	10.85
09/30/99	10.51	11/12/99	10.88	12/25/99	10.50	02/06/00	10.79
10/01/99	10.49	11/13/99	10.88	12/26/99	10.49	02/07/00	10.74
10/02/99	10.48	11/14/99	10.88	12/27/99	10.49	02/08/00	10.71
10/03/99	10.47	11/15/99	10.88	12/28/99	10.48	02/09/00	10.71
10/04/99	10.47	11/16/99	10.87	12/29/99	10.48	02/10/00	10.72
10/05/99	10.50	11/17/99	10.81	12/30/99	10.47	02/11/00	10.73
10/06/99	10.50	11/18/99	10.79	12/31/99	10.46	02/12/00	10.69
10/07/99	10.52	11/19/99	10.79	01/01/00	10.46	02/13/00	10.65
10/08/99	10.52	11/20/99	10.77	01/02/00	10.45	02/14/00	10.61
10/09/99	10.53	11/21/99	10.78	01/03/00	10.45	02/15/00	10.58
10/10/99	10.54	11/22/99	10.79	01/04/00	10.44	02/16/00	10.54
10/11/99	10.55	11/23/99	10.79	01/05/00	10.40	02/17/00	10.50
10/12/99	10.55	11/24/99	10.78	01/06/00	10.36	02/18/00	10.46
10/13/99	10.54	11/25/99	10.76	01/07/00	10.36	02/19/00	10.42
10/14/99	10.56	11/26/99	10.74	01/08/00	10.36	02/20/00	10.37
10/15/99	10.60	11/27/99	10.72	01/09/00	10.36	02/21/00	10.33
10/16/99	10.76	11/28/99	10.71	01/10/00	10.36	02/22/00	10.28
10/17/99	10.93	11/29/99	10.69	01/11/00	10.37	02/23/00	10.22
10/18/99	11.05	11/30/99	10.69	01/12/00	10.38	02/24/00	10.18

Date	Stage (ft)	Date	Stage (ft)	Date	Stage (ft)	Date	Stage (ft)
02/25/00	10.15	03/27/00	11.02	04/28/00	11.45	05/30/00	11.10
02/26/00	10.12	03/28/00	10.97	04/29/00	11.50	05/31/00	11.07
02/27/00	10.10	03/29/00	10.91	04/30/00	11.56	06/01/00	11.03
02/28/00	10.07	03/30/00	10.93	05/01/00	11.61	06/02/00	11.01
02/29/00	10.08	03/31/00	11.04	05/02/00	11.64	06/03/00	11.00
03/01/00	10.09	04/01/00	11.00	05/03/00	11.64	06/04/00	10.99
03/02/00	10.19	04/02/00	10.94	05/04/00	11.63	06/05/00	10.97
03/03/00	10.18	04/03/00	10.90	05/05/00	11.60	06/06/00	10.98
03/04/00	10.22	04/04/00	10.92	05/06/00	11.55	06/07/00	11.03
03/05/00	10.27	04/05/00	10.85	05/07/00	11.50	06/08/00	11.11
03/06/00	10.33	04/06/00	10.85	05/08/00	11.45	06/09/00	11.21
03/07/00	10.42	04/07/00	10.93	05/09/00	11.41	06/10/00	11.26
03/08/00	10.52	04/08/00	10.97	05/10/00	11.39	06/11/00	11.30
03/09/00	10.67	04/09/00	10.99	05/11/00	11.37	06/12/00	11.33
03/10/00	10.76	04/10/00	11.01	05/12/00	11.35	06/13/00	11.35
03/11/00	10.76	04/11/00	11.03	05/13/00	11.30	06/14/00	11.33
03/12/00	10.75	04/12/00	11.07	05/14/00	11.24	06/15/00	11.28
03/13/00	10.75	04/13/00	11.14	05/15/00	11.20	06/16/00	11.24
03/14/00	10.81	04/14/00	11.28	05/16/00	11.18	06/17/00	11.20
03/15/00	10.86	04/15/00	11.33	05/17/00	11.19	06/18/00	11.17
03/16/00	11.04	04/16/00	11.38	05/18/00	11.22	06/19/00	11.13
03/17/00	11.15	04/17/00	11.39	05/19/00	11.20	06/20/00	11.13
03/18/00	11.21	04/18/00	11.30	05/20/00	11.20	06/21/00	11.18
03/19/00	11.29	04/19/00	11.24	05/21/00	11.20	06/22/00	11.24
03/20/00	11.36	04/20/00	11.24	05/22/00	11.21	06/23/00	11.28
03/21/00	11.33	04/21/00	11.30	05/23/00	11.23	06/24/00	11.30
03/22/00	11.30	04/22/00	11.33	05/24/00	11.23	06/25/00	11.31
03/23/00	11.31	04/23/00	11.36	05/25/00	11.24	06/26/00	11.35
03/24/00	11.25	04/24/00	11.38	05/26/00	11.24	06/27/00	11.42
03/25/00	11.17	04/25/00	11.35	05/27/00	11.21	06/28/00	11.46
03/26/00	11.10	04/26/00	11.34	05/28/00	11.17	06/29/00	11.48
		04/27/00	11.39	05/29/00	11.14	06/30/00	11.45

APPENDIX III

STA-1W Water Balance Terms With Calculated Remainders

STA-1W Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Spillway G302_S	Seepage Pump G250S	Outflow Pump G251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
7/1/99	-19.153	0.000	27.782	0.000	1.688	2.218	6.708	-16.351
7/2/99	-10.351	0.000	6.587	0.000	1.926	0.000	6.764	-5.514
7/3/99	-33.696	0.000	0.000	36.003	2.026	2.772	7.429	4.939
7/4/99	-50.364	0.000	0.000	34.741	1.998	2.218	8.316	-11.523
7/5/99	-39.542	0.000	0.000	35.335	1.907	28.274	13.527	-20.861
7/6/99	-22.336	0.000	0.000	32.316	1.698	0.832	15.191	22.641
7/7/99	-32.859	0.000	0.000	29.953	1.539	0.000	13.028	8.583
7/8/99	-40.387	0.000	0.000	26.564	1.471	0.000	10.949	-4.344
7/9/99	-20.997	0.000	0.000	24.440	1.267	0.000	11.975	14.152
7/10/99	-24.789	0.000	0.000	24.068	1.077	0.000	12.502	10.703
7/11/99	-11.967	0.000	0.000	22.772	0.891	33.818	9.369	-14.536
7/12/99	-5.273	0.000	0.000	22.730	0.781	0.000	13.915	30.591
7/13/99	-35.359	3.951	0.000	21.715	0.705	0.000	14.054	-4.246
7/14/99	-28.409	6.919	0.000	19.116	0.654	0.000	12.141	-4.725
7/15/99	-17.006	0.000	10.792	17.377	0.629	0.000	12.502	12.243
7/16/99	-12.552	0.000	13.224	16.457	0.592	1.386	12.502	14.429
7/17/99	-23.677	0.000	8.710	16.055	0.550	6.376	13.694	-0.854
7/18/99	-24.502	0.000	7.144	14.169	0.492	0.000	14.581	3.755
7/19/99	-22.313	0.000	0.037	13.207	0.508	0.000	13.028	3.415
7/20/99	-20.907	0.000	5.167	11.607	0.412	2.218	10.949	-0.980
7/21/99	-7.075	0.000	5.997	12.557	0.348	60.430	13.555	-41.741
7/22/99	26.127	0.000	3.225	14.807	0.332	25.225	10.949	26.327
7/23/99	-0.055	0.000	6.361	13.988	0.462	1.386	13.472	25.557
7/24/99	-18.199	0.000	2.956	16.461	0.468	0.000	14.747	12.542
7/25/99	-29.145	0.000	5.586	15.197	0.465	0.000	14.581	0.168
7/26/99	-20.539	0.000	3.792	11.982	0.472	0.000	11.448	2.418
7/27/99	-15.610	0.000	3.832	8.882	0.475	8.316	12.391	-3.129
7/28/99	-23.384	0.000	3.171	8.133	0.501	0.000	10.922	-4.830
7/29/99	-12.448	0.000	3.364	7.367	0.483	0.000	14.470	8.906
7/30/99	-19.001	0.000	0.000	6.445	0.489	2.772	13.555	-2.262
7/31/99	-111.367	0.000	0.000	6.858	0.476	0.000	14.054	-90.931
8/1/99	-14.251	0.000	5.968	4.871	0.482	0.000	16.105	6.243
8/2/99	-17.103	0.000	3.014	6.141	0.471	0.832	9.702	-2.563
8/3/99	-15.384	0.000	5.579	5.224	0.462	0.000	11.559	0.937
8/4/99	-5.945	0.000	12.314	5.486	0.470	37.422	10.007	-28.344
8/5/99	14.180	0.000	17.719	7.433	0.484	11.365	10.312	20.076
8/6/99	8.256	0.000	22.811	7.573	0.487	10.534	11.033	15.840
8/7/99	4.161	0.000	21.455	8.823	0.458	16.078	11.337	7.786
8/8/99	-1.907	0.000	20.068	10.594	0.445	0.000	13.472	21.714
8/9/99	-8.297	0.000	19.950	9.939	0.424	4.158	8.732	5.791
8/10/99	-10.363	0.000	20.092	11.066	0.420	4.990	11.448	6.742
8/11/99	-8.806	0.000	19.603	11.267	0.398	4.990	14.220	11.294
8/12/99	4.321	0.000	19.363	11.663	0.407	2.218	11.199	24.559
8/13/99	10.970	0.000	20.594	21.526	0.417	59.875	7.124	-20.671
8/14/99	69.902	0.000	20.650	11.438	0.454	58.489	4.103	26.499
8/15/99	1.631	0.000	20.753	28.597	0.456	0.000	12.696	42.468

STA-1W Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Spillway G302_S	Seepage Pump G250S	Outflow Pump G251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
8/16/99	-19.031	0.000	20.410	21.800	0.440	0.000	12.225	14.554
8/17/99	-23.533	0.000	20.058	19.747	0.521	5.544	9.536	-0.315
8/18/99	-9.031	0.000	19.955	20.570	0.537	16.909	4.213	-1.694
8/19/99	-8.287	0.000	19.848	18.911	0.621	9.979	6.764	6.787
8/20/99	-2.528	0.000	17.127	17.898	0.744	6.376	12.114	20.364
8/21/99	-7.977	0.000	17.594	18.962	0.837	0.832	8.427	17.743
8/22/99	-4.221	0.000	16.665	16.222	0.867	0.000	9.619	20.752
8/23/99	-6.076	0.000	18.549	16.153	0.894	0.832	8.177	16.529
8/24/99	-18.987	0.000	24.903	23.540	0.977	70.409	5.766	-61.067
8/25/99	6.481	0.000	27.178	22.686	1.218	0.000	13.999	41.947
8/26/99	7.536	0.000	28.428	23.838	1.325	60.430	13.472	-16.908
8/27/99	4.612	0.000	31.183	25.918	1.301	0.000	14.470	43.699
8/28/99	-14.196	0.000	30.310	22.921	1.246	5.544	13.500	15.434
8/29/99	-12.625	0.000	27.719	20.012	1.158	0.000	14.636	20.866
8/30/99	-22.852	0.000	29.275	19.429	1.100	0.000	14.913	10.391
8/31/99	-13.638	0.000	29.145	19.261	1.048	14.137	7.872	-1.690
9/1/99	25.675	89.381	27.915	21.852	0.929	18.295	13.971	-47.107
9/2/99	53.243	41.090	19.860	27.976	0.989	0.000	12.197	51.336
9/3/99	56.862	119.989	17.046	31.763	0.881	0.000	15.856	-16.390
9/4/99	13.413	0.000	14.790	41.895	0.894	0.000	14.802	69.216
9/5/99	-22.049	44.687	10.489	40.956	0.857	0.000	13.555	-13.083
9/6/99	-29.045	0.000	11.867	39.458	0.853	0.832	10.949	19.678
9/7/99	25.885	45.445	11.876	17.438	0.827	52.114	4.685	-50.378
9/8/99	113.678	105.664	12.960	43.282	0.839	85.932	9.924	-25.551
9/9/99	75.701	101.438	11.977	67.126	0.954	39.362	7.817	8.889
9/10/99	49.971	98.272	11.013	74.307	1.043	0.832	11.310	35.441
9/11/99	-3.710	97.073	10.122	78.163	1.044	0.000	13.028	-10.636
9/12/99	-7.697	74.343	9.579	79.846	1.012	0.000	10.062	6.856
9/13/99	-9.076	131.577	8.713	76.922	0.989	5.544	10.534	-59.730
9/14/99	82.825	168.096	9.527	87.044	0.751	12.751	9.286	-2.444
9/15/99	25.059	22.657	9.674	89.616	0.577	3.604	9.231	97.068
9/16/99	-102.326	56.485	9.366	90.015	0.509	0.000	14.414	-54.891
9/17/99	-37.037	60.424	8.850	75.897	0.503	12.751	6.708	-28.110
9/18/99	2.827	68.620	7.663	73.971	0.572	21.899	7.041	-7.252
9/19/99	15.127	95.268	8.642	73.587	0.704	18.295	6.653	-18.900
9/20/99	-1.115	64.811	9.464	74.740	0.926	58.489	3.216	-47.386
9/21/99	50.506	43.532	9.513	76.700	1.144	0.832	6.043	87.741
9/22/99	-56.133	73.103	8.661	72.440	1.294	0.000	12.335	-45.755
9/23/99	11.921	105.152	8.319	66.484	1.157	0.000	10.977	-16.927
9/24/99	18.869	71.588	8.852	70.509	1.107	10.534	6.985	13.135
9/25/99	27.219	90.969	11.167	77.546	1.140	69.023	3.132	-53.234
9/26/99	25.693	101.830	12.204	82.087	1.276	16.909	4.685	-7.550
9/27/99	24.981	116.268	12.048	84.201	1.606	4.990	8.011	-5.671
9/28/99	35.177	140.945	9.794	88.209	1.605	0.000	12.086	-7.078
9/29/99	41.470	98.524	9.271	94.328	1.481	0.000	10.506	46.299
9/30/99	-24.851	86.004	9.400	96.383	1.452	0.000	12.141	-3.783

STA-1W Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Spillway G302_S	Seepage Pump G250S	Outflow Pump G251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
10/1/99	-35.983	77.392	9.266	92.133	1.430	0.000	8.870	-13.801
10/2/99	-47.881	72.041	9.831	84.561	1.398	0.000	12.502	-24.257
10/3/99	-16.402	70.502	9.378	80.441	1.394	0.000	5.738	-2.119
10/4/99	-13.708	75.415	8.559	79.004	1.465	54.331	5.211	-60.704
10/5/99	33.688	117.973	9.109	80.164	1.704	0.000	7.290	1.465
10/6/99	37.111	87.852	8.456	82.701	1.745	0.000	5.738	35.954
10/7/99	-61.570	0.000	8.982	84.020	2.080	16.909	6.764	10.225
10/8/99	-63.209	59.396	10.751	70.644	2.126	26.057	7.817	-72.327
10/9/99	101.119	150.920	12.552	74.064	2.116	40.748	9.369	-9.233
10/10/99	46.927	139.171	10.095	81.818	2.161	0.000	13.001	0.413
10/11/99	46.641	136.730	9.021	88.290	2.053	2.218	11.448	5.379
10/12/99	27.581	50.554	8.674	93.459	2.098	2.218	8.316	74.488
10/13/99	-97.855	0.000	7.519	92.415	2.447	0.000	10.922	3.035
10/14/99	-100.612	0.000	8.688	74.096	2.758	59.044	2.606	-85.712
10/15/99	48.351	0.000	6.839	45.467	3.595	415.523	1.053	-324.247
10/16/99	320.017	0.000	0.000	0.000	4.824	6.376	6.764	315.581
10/17/99	47.242	0.000	17.844	54.655	5.286	0.000	9.342	105.952
10/18/99	-27.584	0.000	23.491	91.945	5.805	0.000	10.922	69.477
10/19/99	-86.866	0.000	15.816	88.431	6.159	0.000	10.922	6.329
10/20/99	-85.974	0.000	11.064	80.083	6.347	74.012	9.369	-76.881
10/21/99	-11.968	105.365	9.471	65.985	5.948	0.000	9.369	-47.926
10/22/99	57.292	169.200	7.888	64.987	5.176	0.000	7.789	-44.308
10/23/99	74.900	154.424	7.984	77.879	4.588	0.000	12.474	6.241
10/24/99	50.278	66.837	6.812	88.561	4.157	0.000	12.446	80.291
10/25/99	-79.022	0.000	7.678	90.717	4.212	0.000	10.367	17.851
10/26/99	-113.161	37.963	8.930	76.758	4.108	0.000	5.184	-73.290
10/27/99	-18.974	101.113	9.077	64.072	3.670	1.386	10.894	-50.177
10/28/99	9.481	97.460	9.846	65.628	3.213	0.000	9.841	-15.723
10/29/99	18.859	95.984	9.687	68.315	2.912	0.832	8.815	-3.740
10/30/99	8.705	78.784	9.033	70.257	2.747	0.000	9.342	6.773
10/31/99	10.759	72.868	11.201	71.126	2.711	154.123	8.288	-139.529
11/1/99	56.924	9.268	13.944	81.899	3.224	4.990	9.868	131.210
11/2/99	-62.941	58.540	11.003	69.964	3.786	14.137	6.764	-62.677
11/3/99	-6.029	93.379	11.008	66.636	3.517	0.000	11.947	-24.341
11/4/99	-28.590	81.720	15.620	67.424	3.149	0.000	9.314	-36.722
11/5/99	-70.026	0.000	15.776	66.210	3.058	0.000	9.314	2.441
11/6/99	-69.076	0.000	14.866	57.823	3.058	0.000	7.762	-6.549
11/7/99	-60.603	0.000	13.902	50.016	3.065	0.000	8.815	-4.837
11/8/99	-55.754	0.000	13.440	44.552	3.102	0.000	9.314	-4.990
11/9/99	-63.966	0.000	13.535	36.850	3.168	0.000	9.841	-20.444
11/10/99	-40.634	0.056	13.036	33.062	3.192	0.000	9.314	-1.506
11/11/99	-37.859	0.000	13.029	28.759	3.163	0.000	7.263	-5.001
11/12/99	-3.323	58.082	12.955	26.011	2.921	0.000	10.894	-27.422
11/13/99	-0.251	0.000	13.450	26.031	2.940	0.000	9.314	32.154
11/14/99	-28.252	0.000	13.251	25.458	2.967	0.000	9.841	4.080
11/15/99	15.925	73.543	14.546	23.643	2.676	0.000	10.367	-26.284

STA-1W Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Spillway G302_S	Seepage Pump G250S	Outflow Pump G251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
11/16/99	40.764	66.409	14.379	24.895	2.564	0.000	9.841	6.527
11/17/99	16.360	61.987	14.274	30.024	2.408	0.000	6.209	-11.803
11/18/99	20.694	70.433	15.358	35.316	2.303	0.000	7.235	-9.492
11/19/99	16.712	56.154	15.069	39.512	2.212	0.000	7.235	5.092
11/20/99	2.450	50.605	14.996	41.665	2.171	0.000	7.235	-1.426
11/21/99	19.740	55.805	14.915	43.789	2.112	0.000	6.209	11.822
11/22/99	11.666	63.015	15.953	44.648	2.052	0.000	5.184	-3.570
11/23/99	6.076	53.456	15.414	46.522	2.068	0.000	3.631	0.705
11/24/99	-2.956	50.118	14.162	46.710	2.085	0.000	3.105	-5.344
11/25/99	-31.668	0.000	14.531	46.103	2.172	4.990	3.631	10.905
11/26/99	-23.492	50.965	14.485	41.636	2.175	0.000	4.657	-30.339
11/27/99	3.648	61.530	14.668	40.836	2.122	0.000	7.762	-11.407
11/28/99	7.756	60.938	14.325	42.827	2.104	0.000	7.263	-5.195
11/29/99	1.320	58.807	14.776	44.491	2.055	0.000	6.736	-8.315
11/30/99	4.679	59.475	14.379	46.740	1.978	0.000	6.736	-3.298
12/1/99	-4.169	59.695	13.797	48.834	1.927	0.000	7.762	-9.195
12/2/99	-15.654	50.194	13.090	47.956	1.898	0.000	8.261	-11.530
12/3/99	-15.381	56.360	13.007	46.434	1.901	0.000	5.683	-21.526
12/4/99	9.059	67.422	13.462	46.977	1.855	0.000	4.130	-9.111
12/5/99	1.866	50.762	13.281	48.315	1.873	3.604	3.604	-2.454
12/6/99	-3.706	55.044	13.814	53.003	1.884	0.000	5.683	-1.948
12/7/99	-5.052	34.354	13.440	48.418	1.828	0.832	6.209	12.561
12/8/99	-1.413	58.956	13.261	47.001	1.808	0.000	6.736	-8.439
12/9/99	5.950	61.099	13.339	47.312	1.774	0.000	6.736	-2.876
12/10/99	14.066	59.866	14.707	48.149	1.744	0.832	3.631	3.405
12/11/99	4.411	55.531	18.208	48.856	1.744	0.000	5.683	1.675
12/12/99	2.557	54.951	21.671	49.835	1.733	5.544	3.631	-6.205
12/13/99	-4.716	50.539	21.971	49.622	1.761	2.218	6.736	-2.876
12/14/99	-25.209	53.781	21.685	50.106	1.718	4.158	3.105	-31.656
12/15/99	6.003	56.404	21.052	52.377	1.640	0.832	3.631	3.136
12/16/99	-3.299	48.773	20.638	53.485	1.593	0.000	3.631	3.452
12/17/99	-10.386	47.611	20.802	52.727	1.658	9.979	6.209	-10.698
12/18/99	-0.523	51.799	21.328	50.703	1.741	2.218	5.683	0.105
12/19/99	-6.511	44.924	21.394	49.519	1.764	0.000	8.288	4.608
12/20/99	-10.966	34.479	21.379	49.903	1.647	1.386	5.184	6.609
12/21/99	-3.104	59.788	20.941	48.738	1.658	3.604	3.631	-15.783
12/22/99	10.924	63.695	20.844	49.030	1.658	0.832	7.263	1.032
12/23/99	13.510	62.805	21.516	53.461	1.600	11.920	5.184	-4.170
12/24/99	-5.324	47.393	21.149	56.619	1.553	0.000	7.762	10.111
12/25/99	-38.162	8.353	20.866	52.776	1.540	0.000	9.813	14.533
12/26/99	-28.973	31.396	20.814	47.378	1.564	0.000	8.760	-5.795
12/27/99	-0.606	62.110	19.356	56.238	1.538	0.000	9.286	1.270
12/28/99	16.152	52.651	12.128	45.093	1.575	11.920	3.077	-1.824
12/29/99	-2.390	56.338	8.258	46.600	1.545	0.832	9.258	-5.246
12/30/99	-2.612	55.271	9.300	46.947	1.488	0.000	9.258	-3.165
12/31/99	-3.433	53.764	8.231	47.026	1.472	0.000	9.258	-2.385

STA-1W Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Spillway G302_S	Seepage Pump G250S	Outflow Pump G251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
1/1/00	-2.256	54.349	8.683	47.036	1.439	0.000	7.928	-3.080
1/2/00	-8.655	52.355	8.522	47.268	1.445	0.000	7.540	-7.647
1/3/00	-2.933	58.648	9.168	46.505	1.430	0.000	7.429	-9.076
1/4/00	-28.569	0.000	13.795	45.668	1.482	0.000	8.011	23.629
1/5/00	-51.867	57.659	18.837	42.101	1.411	0.832	8.233	-61.435
1/6/00	22.629	53.077	25.057	40.623	1.376	2.772	9.064	15.091
1/7/00	-2.717	36.806	27.063	43.319	1.372	2.218	6.015	6.222
1/8/00	0.474	47.515	27.335	44.156	1.327	0.832	8.233	3.189
1/9/00	-8.904	37.119	26.789	43.008	1.326	0.000	7.983	3.643
1/10/00	0.406	50.214	26.647	41.379	1.315	0.000	8.787	-0.958
1/11/00	13.698	53.275	26.383	41.853	1.245	0.832	5.599	5.800
1/12/00	3.582	51.119	26.422	43.997	1.215	0.832	9.979	4.392
1/13/00	-2.513	46.297	26.390	44.234	1.201	0.000	9.563	3.787
1/14/00	1.085	50.052	26.368	46.996	1.069	0.000	9.148	6.108
1/15/00	-5.666	55.780	26.072	48.800	1.113	0.000	5.100	-8.660
1/16/00	1.374	53.448	26.031	46.084	1.125	0.000	6.182	-0.934
1/17/00	3.235	49.886	26.165	46.052	1.100	0.000	9.841	8.141
1/18/00	15.180	112.492	25.336	46.189	1.037	0.832	9.702	-43.291
1/19/00	46.720	117.545	25.409	49.803	0.984	0.832	6.653	-16.185
1/20/00	35.389	107.553	24.863	56.115	0.936	0.832	8.261	-9.554
1/21/00	62.751	136.916	25.588	63.820	0.885	0.000	10.312	-0.918
1/22/00	18.336	98.722	25.810	70.084	0.875	0.000	9.841	-1.338
1/23/00	-16.660	84.228	26.755	67.343	0.892	0.000	9.342	-25.094
1/24/00	21.956	78.508	24.100	68.055	0.892	27.443	3.964	-12.868
1/25/00	-3.680	59.785	23.178	63.487	1.054	0.000	6.791	5.760
1/26/00	-38.207	52.590	27.738	56.773	1.057	0.000	10.866	-24.214
1/27/00	-16.082	91.906	28.340	49.524	1.081	0.000	10.894	-48.652
1/28/00	49.815	138.092	28.284	49.093	1.048	13.306	7.457	-46.081
1/29/00	51.897	116.138	29.583	54.914	1.009	0.832	7.623	-3.545
1/30/00	26.055	99.131	29.510	58.914	1.006	0.832	9.175	-6.824
1/31/00	30.588	92.968	32.402	61.141	0.999	0.000	7.124	4.886
2/1/00	23.835	89.214	31.937	61.552	0.982	0.000	7.179	2.370
2/2/00	-8.023	46.916	32.458	63.864	0.979	0.000	3.770	11.717
2/3/00	-49.640	0.000	31.871	61.591	1.042	0.000	5.766	16.675
2/4/00	-56.547	0.000	32.382	51.846	1.097	0.000	8.399	2.601
2/5/00	-55.667	0.000	32.032	45.543	1.128	0.000	11.504	0.252
2/6/00	-65.579	0.000	32.084	40.909	1.088	0.000	8.926	-16.832
2/7/00	-42.473	0.000	32.091	38.871	1.081	0.000	7.789	3.107
2/8/00	-28.672	0.000	32.164	33.982	1.190	35.204	2.412	-28.673
2/9/00	82.507	117.337	31.511	30.303	1.067	17.741	11.448	-11.887
2/10/00	102.593	144.625	31.235	41.616	0.993	0.000	11.753	10.345
2/11/00	76.502	23.528	31.350	56.509	0.976	0.832	11.393	119.070
2/12/00	-73.355	0.000	31.717	57.796	1.021	0.000	9.674	-6.906
2/13/00	-53.271	0.000	31.834	49.340	1.069	0.000	9.342	4.343
2/14/00	-58.157	0.000	31.961	40.726	1.119	0.000	10.534	-8.017
2/15/00	-40.038	0.000	32.103	39.412	1.095	0.000	11.975	10.254

STA-1W Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Spillway G302_S	Seepage Pump G250S	Outflow Pump G251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
2/16/00	-36.810	0.000	32.059	34.897	1.098	0.000	11.836	8.826
2/17/00	-34.708	0.000	32.081	32.999	1.125	0.000	12.252	9.418
2/18/00	-44.480	0.000	32.116	32.580	1.157	0.000	10.035	-3.022
2/19/00	-33.425	0.000	32.155	24.306	1.136	0.000	9.425	-0.831
2/20/00	-33.036	0.000	32.238	26.618	1.084	0.000	10.866	3.364
2/21/00	-27.651	0.000	32.270	24.225	1.016	0.000	12.613	8.170
2/22/00	-34.084	0.000	32.226	21.751	1.017	0.000	9.979	-3.371
2/23/00	-31.778	0.000	32.172	20.954	1.029	0.000	9.397	-2.457
2/24/00	-23.667	0.000	31.697	19.065	1.027	1.386	10.644	3.629
2/25/00	-20.020	0.000	30.799	18.734	1.010	1.386	9.092	5.411
2/26/00	-17.154	0.000	30.919	16.687	0.999	0.000	8.898	7.432
2/27/00	-16.519	0.000	30.836	16.701	1.006	0.000	9.342	8.518
2/28/00	-21.629	0.000	30.173	16.679	0.952	0.000	9.619	3.717
2/29/00	5.333	0.000	29.451	5.789	0.952	0.000	11.836	22.006
3/1/00	26.325	64.872	28.338	0.000	0.835	0.000	12.030	-27.352
3/2/00	51.309	0.000	22.314	0.000	0.875	0.000	10.173	60.607
3/3/00	4.798	35.213	17.702	0.000	0.793	0.000	8.371	-22.836
3/4/00	21.358	28.247	16.320	0.000	0.731	0.000	9.924	2.304
3/5/00	21.689	31.382	16.322	0.000	0.660	0.000	12.668	2.316
3/6/00	24.532	46.108	16.312	0.000	0.601	0.000	9.813	-12.365
3/7/00	36.558	47.400	16.307	0.000	0.574	0.000	9.619	-1.797
3/8/00	39.650	53.622	16.310	0.000	0.551	0.000	10.700	-3.824
3/9/00	60.079	55.083	16.310	0.000	0.568	0.000	13.444	17.873
3/10/00	35.108	0.000	16.312	0.000	0.606	0.000	11.947	46.449
3/11/00	14.093	0.000	17.374	0.000	0.583	37.422	7.762	-16.150
3/12/00	22.479	0.000	17.819	0.000	0.551	0.000	10.506	32.434
3/13/00	-3.743	54.713	17.054	20.484	0.506	0.000	13.278	-25.201
3/14/00	-8.355	42.952	16.227	23.246	0.518	0.000	12.197	-16.382
3/15/00	28.174	113.833	19.495	31.142	0.511	0.832	10.450	-45.410
3/16/00	126.265	114.472	30.251	21.184	0.531	0.000	12.252	44.698
3/17/00	86.485	103.655	31.352	32.803	0.427	0.000	13.001	28.206
3/18/00	96.217	66.692	31.908	36.199	0.382	6.376	5.405	64.371
3/19/00	112.542	77.933	31.668	57.982	0.593	204.296	2.024	-110.274
3/20/00	256.247	264.171	31.357	65.459	0.856	0.832	12.557	68.405
3/21/00	174.057	227.855	30.224	94.245	0.949	0.832	14.775	53.441
3/22/00	105.787	155.736	16.491	102.429	0.722	0.832	14.054	64.981
3/23/00	-28.180	3.283	19.429	105.270	0.676	0.832	13.389	85.687
3/24/00	-121.613	4.338	28.267	104.536	0.719	0.832	10.312	-12.654
3/25/00	-123.406	4.744	30.290	96.405	0.780	1.386	13.888	-20.024
3/26/00	-102.810	4.707	30.618	84.666	0.817	0.000	10.589	-13.080
3/27/00	-83.634	13.545	30.508	70.468	0.849	2.218	7.983	-21.794
3/28/00	-76.639	2.447	29.745	68.403	0.888	3.604	14.553	-0.621
3/29/00	-83.492	25.712	30.594	64.116	0.946	2.218	12.973	-35.280
3/30/00	18.151	111.435	31.634	55.951	0.913	0.000	13.389	-24.858
3/31/00	32.961	4.859	32.069	60.664	0.921	0.000	12.197	100.041
4/1/00	-97.728	0.000	32.341	58.374	0.970	0.000	12.446	-27.878

STA-1W Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Spillway G302_S	Seepage Pump G250S	Outflow Pump G251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
4/2/00	-77.429	0.000	32.470	48.144	1.022	0.000	12.945	-17.362
4/3/00	-33.279	0.000	32.541	13.029	1.048	0.000	14.498	-6.801
4/4/00	16.894	0.000	32.465	0.000	0.978	0.000	12.945	28.861
4/5/00	-42.786	0.000	32.409	14.693	0.886	0.000	16.577	-12.403
4/6/00	-17.831	33.312	28.521	17.484	0.914	0.000	13.472	-21.100
4/7/00	33.707	51.838	16.378	17.394	0.908	0.000	14.498	12.852
4/8/00	-6.349	0.000	16.364	17.369	0.931	0.000	13.472	23.561
4/9/00	-25.682	0.000	16.339	13.009	0.848	0.000	16.577	3.055
4/10/00	-7.413	0.991	16.288	0.000	0.872	0.000	14.498	5.222
4/11/00	-2.828	0.000	16.234	0.000	0.872	0.000	13.999	10.299
4/12/00	14.937	0.000	16.209	0.000	0.862	23.285	6.736	-2.474
4/13/00	56.759	111.511	15.872	27.929	0.866	42.966	4.657	-65.998
4/14/00	199.326	173.330	13.988	60.329	1.093	164.102	1.552	-77.318
4/15/00	279.739	225.477	26.620	82.114	1.230	30.215	8.815	113.746
4/16/00	199.614	85.684	29.113	87.556	0.740	31.046	13.999	183.699
4/17/00	-31.638	0.000	30.601	87.979	1.712	11.920	12.945	55.654
4/18/00	-88.464	39.265	30.185	88.047	1.718	0.000	15.024	-26.376
4/19/00	-26.102	92.598	27.848	90.323	1.407	0.000	16.577	-13.208
4/20/00	-51.970	1.099	28.206	90.749	1.234	0.000	12.446	48.891
4/21/00	-117.631	0.000	30.263	95.368	1.248	0.000	14.498	-9.013
4/22/00	-138.776	0.000	27.107	86.513	1.254	0.000	15.551	-37.966
4/23/00	-91.046	0.000	24.832	59.888	1.216	0.000	16.050	-16.324
4/24/00	-64.012	0.000	25.130	44.745	1.246	0.000	14.498	-6.015
4/25/00	-55.267	0.509	26.845	32.974	1.114	2.772	11.920	-14.768
4/26/00	-1.859	103.415	25.402	32.994	0.859	0.000	16.577	-56.562
4/27/00	50.705	73.526	26.542	34.562	0.706	0.000	15.551	26.586
4/28/00	89.287	125.318	25.184	36.241	0.550	0.000	16.577	16.237
4/29/00	90.793	133.223	25.918	50.896	0.397	0.000	10.894	18.962
4/30/00	86.034	135.225	27.711	66.497	0.273	0.000	14.498	31.530
5/1/00	51.618	129.478	27.689	84.047	0.241	0.000	16.050	21.996
5/2/00	41.898	132.196	28.008	87.122	0.248	0.000	14.498	11.074
5/3/00	37.907	55.418	28.915	86.479	0.272	0.000	7.762	76.457
5/4/00	-105.965	20.572	31.372	99.116	0.413	0.000	15.551	-12.283
5/5/00	-75.137	45.423	32.465	81.356	0.373	0.000	16.577	-23.001
5/6/00	-43.471	51.281	31.560	71.946	0.384	0.000	14.498	-8.693
5/7/00	-55.886	44.068	31.607	59.421	0.355	0.000	14.498	-26.390
5/8/00	-21.201	58.821	31.604	55.567	0.359	0.000	8.815	-16.000
5/9/00	-11.897	53.896	31.589	53.143	0.403	0.000	16.050	2.996
5/10/00	-9.338	70.918	31.521	51.290	0.331	0.000	17.103	-12.194
5/11/00	-1.436	63.744	29.184	53.683	0.289	0.000	16.050	4.263
5/12/00	-9.305	60.666	31.602	53.289	0.342	0.000	17.103	0.079
5/13/00	-22.530	27.352	28.761	51.912	0.305	0.000	13.999	15.724
5/14/00	-69.968	0.000	31.910	49.930	0.307	0.000	16.577	-3.769
5/15/00	-54.567	0.000	30.723	40.513	0.300	13.306	15.024	-12.636
5/16/00	-31.233	0.000	23.726	37.420	0.270	0.000	16.050	21.966
5/17/00	-41.485	0.000	18.321	52.440	0.254	0.000	10.894	21.595

STA-1W Water Balance terms with calculated remainders

Date	Change in Storage	Inflow Spillway G302_S	Seepage Pump G250S	Outflow Pump G251	Seepage L-7a	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
5/18/00	-28.888	0.000	16.349	27.286	0.236	0.000	15.551	13.713
5/19/00	-8.300	99.562	15.965	20.496	0.190	0.000	14.498	-73.058
5/20/00	90.515	107.430	15.561	25.872	0.191	0.000	17.602	26.368
5/21/00	8.734	16.855	13.278	36.087	0.176	0.000	17.602	45.391
5/22/00	-40.661	0.000	14.242	34.092	0.134	0.000	15.024	8.322
5/23/00	-28.326	0.000	16.031	27.719	0.097	26.057	13.472	-13.289
5/24/00	-18.601	0.000	16.028	26.376	0.071	16.078	13.999	5.625
5/25/00	-20.158	0.000	12.087	20.222	0.040	7.762	16.050	8.312
5/26/00	-23.813	0.000	11.338	20.469	0.012	0.000	16.050	12.695
5/27/00	-38.708	0.000	15.683	17.396	0.000	0.000	11.920	-9.392
5/28/00	-37.852	0.000	12.082	17.345	0.000	0.000	15.551	-4.956
5/29/00	-32.109	0.000	13.401	11.800	0.000	0.000	16.577	-3.732
5/30/00	-29.819	0.000	31.034	46.629	0.000	0.000	13.472	30.282
5/31/00	-19.256	0.000	18.010	5.752	0.000	0.000	15.024	1.520
6/1/00	-15.036	0.000	4.879	0.000	0.000	0.000	15.551	0.515
6/2/00	-13.963	0.000	18.013	0.000	0.000	0.000	16.577	2.614
6/3/00	-7.281	0.000	12.708	0.000	0.000	0.000	16.050	8.769
6/4/00	-7.636	0.000	14.959	0.000	0.000	0.000	12.945	5.309
6/5/00	8.248	34.763	16.926	0.000	0.000	0.000	17.103	-9.412
6/6/00	-5.939	41.181	13.481	19.515	0.000	0.000	14.498	-13.107
6/7/00	-8.331	32.098	13.521	12.537	0.000	0.000	13.472	-14.421
6/8/00	27.170	46.118	8.625	9.256	0.000	11.365	5.710	-15.347
6/9/00	29.647	46.502	12.378	7.401	0.000	0.000	12.945	3.491
6/10/00	12.465	0.245	18.013	5.838	0.000	0.832	14.498	31.724
6/11/00	31.850	0.000	17.633	10.386	0.000	56.272	8.288	-5.747
6/12/00	21.540	0.000	15.128	6.616	0.000	0.000	16.050	44.205
6/13/00	0.344	0.000	18.010	6.481	0.000	0.000	12.446	19.272
6/14/00	-18.637	0.000	11.783	5.454	0.000	0.000	13.999	0.815
6/15/00	-31.598	0.000	18.013	1.515	0.000	0.000	15.024	-15.059
6/16/00	-28.342	0.000	11.820	2.860	0.000	0.000	17.602	-7.880
6/17/00	-18.888	0.000	12.603	4.314	0.000	2.218	16.050	-0.743
6/18/00	-21.349	0.000	14.042	0.000	0.000	0.000	15.024	-6.325
6/19/00	-20.127	0.000	12.985	5.713	0.000	4.158	10.894	-7.678
6/20/00	11.440	57.363	17.352	0.000	0.000	0.000	16.050	-29.874
6/21/00	58.407	54.427	10.337	1.806	0.000	0.000	10.367	16.153
6/22/00	38.430	55.391	12.109	7.732	0.000	0.000	13.472	4.242
6/23/00	29.876	48.856	14.759	6.978	0.000	0.000	15.551	3.549
6/24/00	10.260	0.000	10.244	11.989	0.000	0.000	11.393	33.642
6/25/00	-18.040	0.000	12.493	8.145	0.000	1.386	5.184	-6.097
6/26/00	14.568	99.547	17.227	5.728	0.000	0.000	12.446	-66.805
6/27/00	90.633	78.400	19.478	10.797	0.000	5.544	6.209	23.695
6/28/00	32.826	0.000	24.032	13.195	0.000	0.000	10.894	56.915
6/29/00	-21.145	0.000	26.106	17.372	0.000	1.386	8.288	3.129
6/30/00	-16.502	0.000	27.134	10.457	0.000	16.909	12.945	-10.008